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framing the issues of cloud computing & sustainability: a design perspective

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human-computer interaction/design (HCI/d)

@ the school of informatics & computing (SoIC)

indiana university at bloomington

Framing the Issues of Cloud Computing & Sustainability: A Design Perspective

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Abstract

In this paper, we describe the present lack of understanding about if the potential environmental effects of transitions to cloud computing are positive or negative. We describe that research about the human interactivity implications of and for cloud computing has yet to enter the arena of Human Computer Interaction (HCI) in a significant way. We describe a short inventory of what is presently in the HCI literature apropos of cloud computing and interactivity. In addition, we offer a description of how we think the issues of cloud computing in the perspective of HCI may be framed, as well as an inventory of social issues implicated in cloud computing. Finally, we suggest some projects and problems that may be appropriate for advancing cloud computing in the perspective of HCI with sustainability as a key goal.

1. Introduction

Cloud computing is an important trend—however historically precedented—which has implications for the way in which people interact with digital technologies. Some of the notions now associated with cloud computing humanity-centered point of view. Do the promised efficiencies of cloud computing have implications for more sustainable practices or will these efficiencies create greater resource and energy use and less sustainable behaviors corresponding to the possibility that greater capabilities induce greater use?

2. Potential positive and negative environmental impacts of cloud computing

Figure 1 frames the problem of how to assess the environmental impacts of cloud computing with respect to the single issue of energy use. Over time, if cloud computing practices increase and conventional distributed physical practices decrease, then the question is will net energy use correspond to decreased, increased, or similar energy use then if cloud computing does not increase?

While one can measure the energy use of storing some unit of information in the virtual space of the cloud compared to storing that same unit of information in some number of possibly redundant physical locations, such measurement only tells part of the story. The issue is not so much one of faith in the efficiencies of less redundant,

call from Greenpeace—

*"The cloud is growing at a time when climate change and reducing emissions from energy use is of paramount concern. With the growth of the cloud, however, comes an **increasing** demand for energy. For all of this content to be delivered to us in real time, virtual mountains of video, pictures and other data must be stored somewhere and be available for almost instantaneous access. That 'somewhere' is data centers - massive storage facilities that consume **incredible amounts of energy**."*

Greenpeace (2010). Make IT Green: cloud computing and its Contribution to Climate Change. The Netherlands: Greenpeace International.

overview

In this paper, we describe the present lack of understanding about if the potential environmental effects of transisting use of cloud computing is positive or negative. We should Also, we describe a short inventory of what is presently in the HCI literature apropos of cloud computing and interactivity, as well as a discussion of what a discipline apropos of and for In addition, we offer a description of how we think the issues of cloud computing may be framed in the perspective of HCI as well as an inventory of social issues implicated in cloud computing. We offer a description of how we think the issues of cloud computing in the perspective of HCI may be framed, as well as an inventory of social issues implicated in cloud computing. In addition, we offer a description of how we think the issue of cloud computing in the perspective of HCI may be framed, as well as an inventory of social issues implicated in cloud computing.

environmental impact of cloud computing

HCI and cloud computing as of now

inventory of issues

potential positive and negative environmental impact of cloud computing

net effect question:
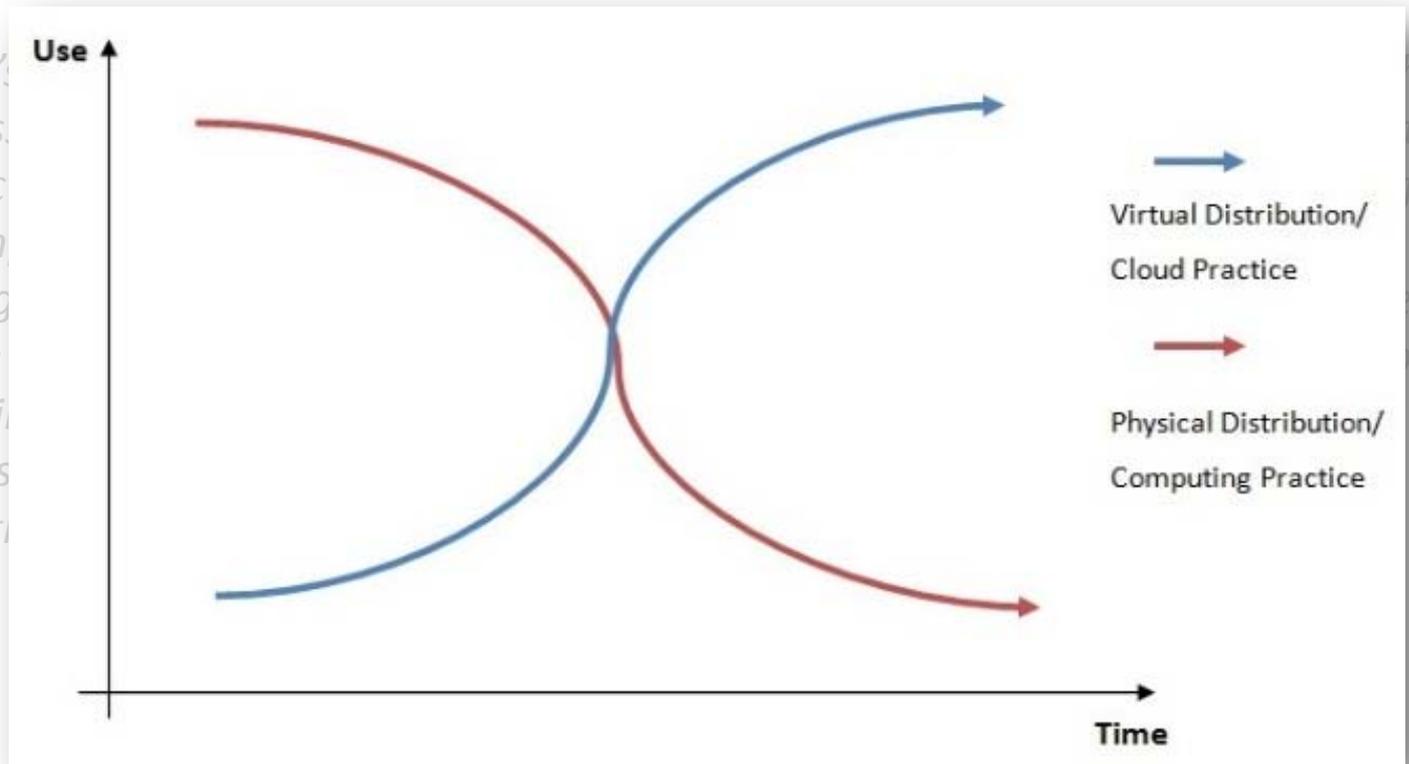
Perhaps Greenpeace'... how how to access the as... tors environmental impac... f impacts of cloud com... With respect of energ... w use. Over time, there ... e an increasing use of i... relatively decrease us... future as a result of t...

net effect question:

Energy Use

A

B

Is A>B?

Is A<B?

Is A=B?

Virtual Distribution/
Cloud Practice

Physical Distribution/
Computing Practice

Time
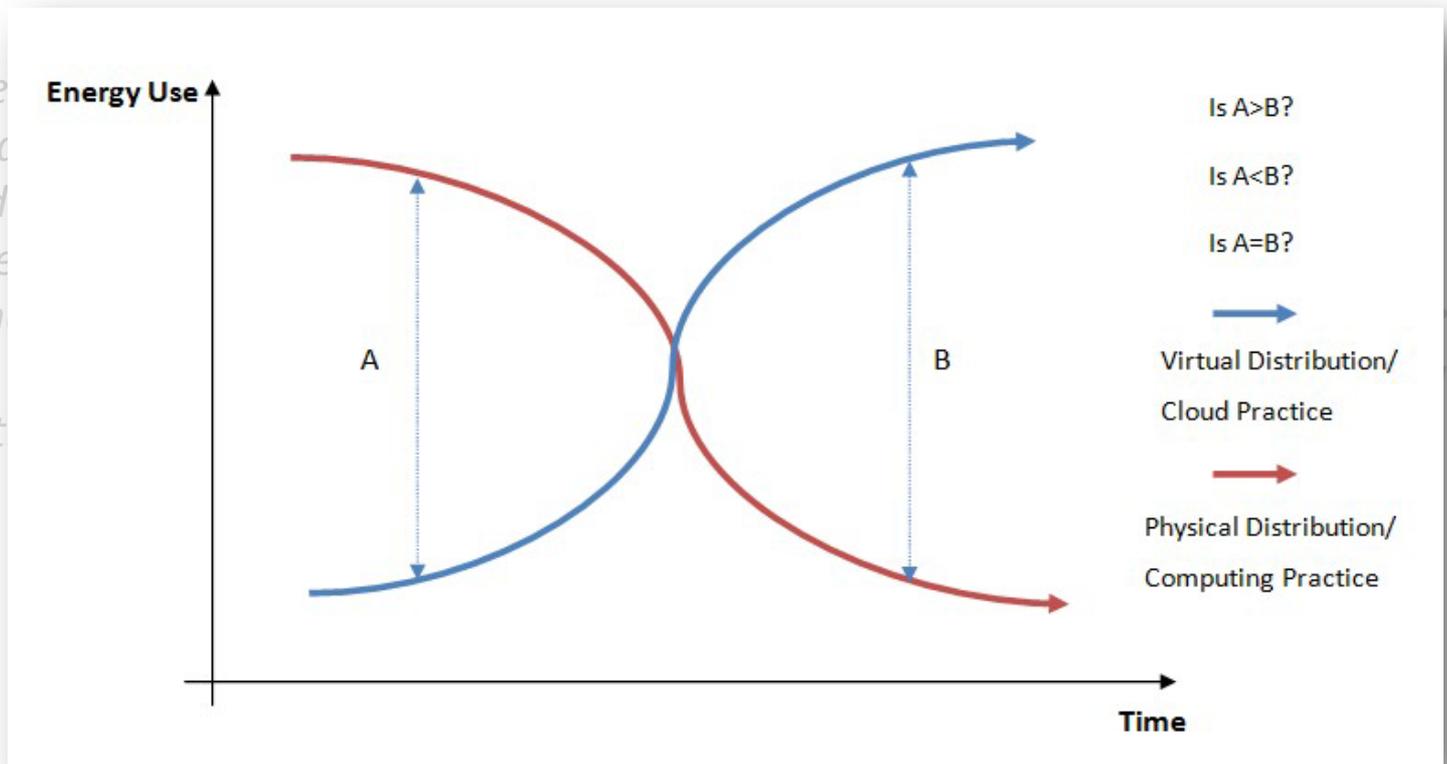
which one save more energy, physical device or cloud practice?

So compare the environmental cost of purchasing a DVD ... of the ... and ... the tipping point—the po... feedback ... likelihood of a period ... less of ou... is—global warming y... ASABLA ...pogeni... Among the implicat... lock e... the Earth's populat... peo...

If Lovelock's view see... note t... he IPCC for predicting gree... ver the c...), The way in which cloud bas... may change h... the continuing frequent obsolescence of conventional physical storage technologies and changes in bandwidth and resolution, changes in how much media the person consumers with the increased availability and speed of access and so on so forth.

is Greenpeace too simple?

what is needed—

contribution of an HCI and design—

best predictions about how behaviors will be changed in the future as a result of the adoption of cloud computing practices

HIC and cloud computing as of now

interaction design in cloud computing

—implication for interaction design and human mental model of interactivity;

"As resources are no longer physically stored on a specific device, it becomes clear that Cloud Computing influences the user mental model and experience with digital artifacts, especially in terms of organization and retrieval of information." by Terrenghi et al.

interaction design in cloud computing

— promote a consistent cognitive mapping across multiple access devices

it is necessary and essential that novel user interfaces are required to convey a conceptual model "*that allows people to navigate and orient themselves in the Cloud, and to define their landmarks for finding and using their information at any time and from any device.*"

interactive application—Cloudroom

Cloudroom
Interaction design inc... ...device and software
targeted at Cloud com... ...computer devices
Visualization and des... ...of objects, people,
management of reso... ...where the interface or
in the cloud computin... ...rphous clouds, service
paradigm. It is design... ...ess of these points of
access [12].

[17] Terrenghi, L., Ser... ...om: a conceptual
model for managing c... ...the international
Conference Extended... ...Atlanta, Georgia, USA,
April 10 - 15, 2010). C...

iCloud—

based on notion that interaction design should be a first-class concern rather than an after-thought.

it "*focused on how dynamic aspects of interactions can help address important issues in cloud programming.*"

energy star program

use consumer labeling and tax incentives to promote the reduction of energy consumption and GHG emissions.

motivation
— raise consumer awareness of GHG emission;
— induce efficient industrial usage of resource;
— promote consumers of green corporate practices.

Energy Star Program

The Energy Star Program (www.energystar.gov) is not specifically associated with the HCI literature, but it is nonetheless an important mechanism of awareness for people to understand the relative effects of certain systems compared to certain other systems. The Energy Star Program uses consumer labeling and even tax incentives to promote the reduction of energy consumption and greenhouse gas emissions.

How can design raise awareness among general populations about the negative effects of GHG emissions on the environment? How can design induce companies and industrial segments to direct resources towards energy efficiency?

How can design promote an understanding among consumers about the link between what they buy and the environment, and the energy star program uses consumer labeling and even tax and how can consumer demand promote green corporate practices?

eco-visualization

promote energy conservation and other sustainable behaviors

motivation

—apply eco-visualization to inform cloud stakeholders about effects of cloud computing practice.

Eco-visualization

Eco-visualizations have been used in interaction design to promote energy conservation and other sustainable behaviors. An inventory and analysis of eco-visualizations is described in Pierce et al. [14], where the following list of design and evaluation strategies is promoted. In considering Eco-visualizations with respect to cloud computing and HCI/design considerations, we need to ask the question of how such Eco-visualizations can be applied to inform cloud stakeholders about the effects of various cloud computing practices.

Pierce, J.,et al. (2008). Energy aware dwelling: a critical survey of interaction design for eco-visualizations. OZCHI '08, vol. 287. ACM, New York, NY, 1–8.
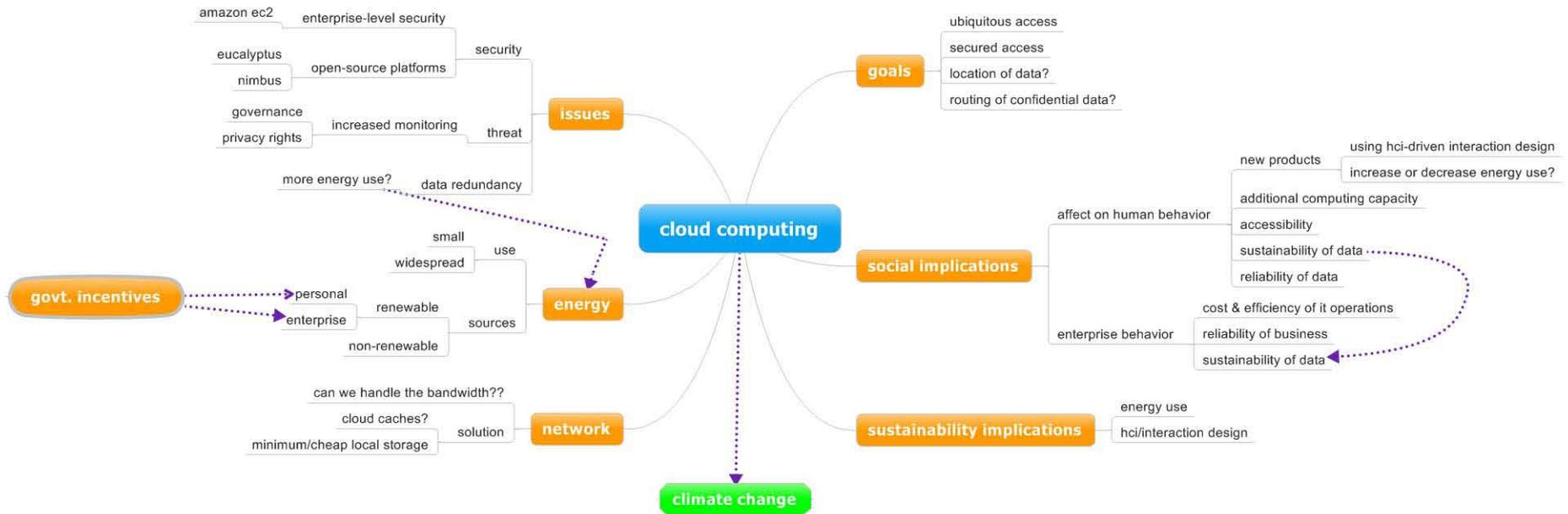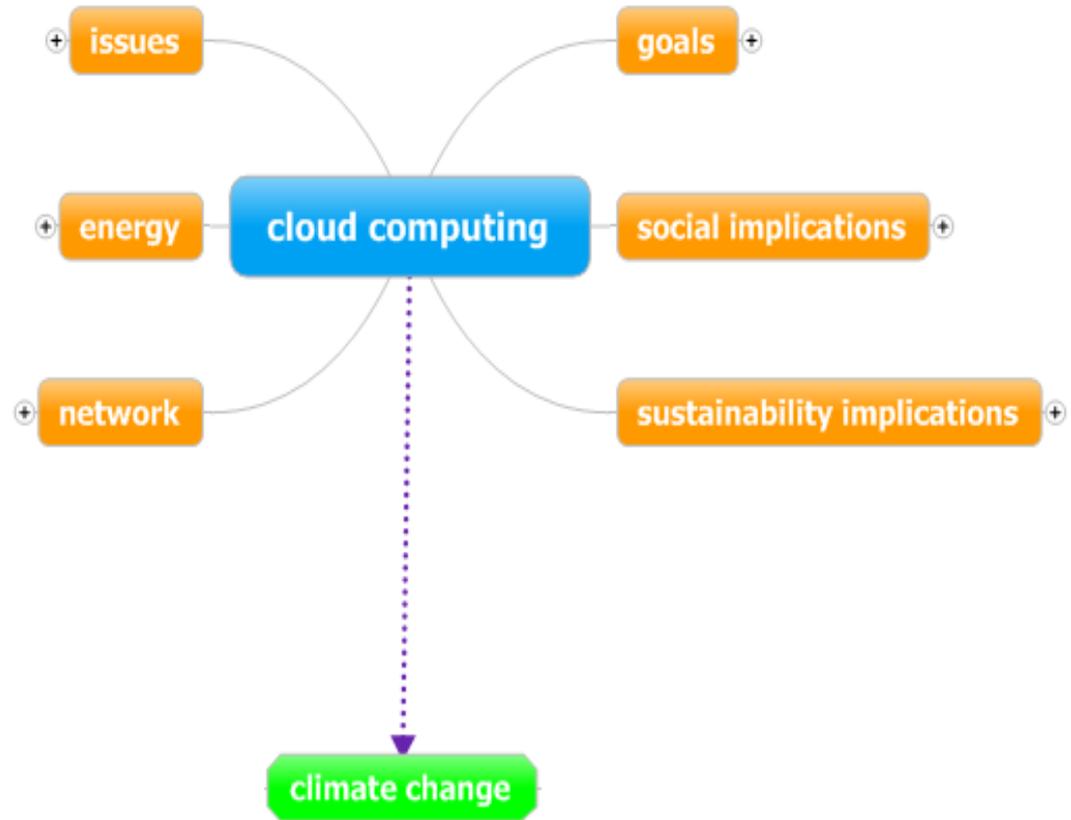
Reach4Cloud

provide interactive space that allow users transparent access to resources and services.

motivation

—derive design principles to ensure systems like Reach4Cloud meet effective design goals.
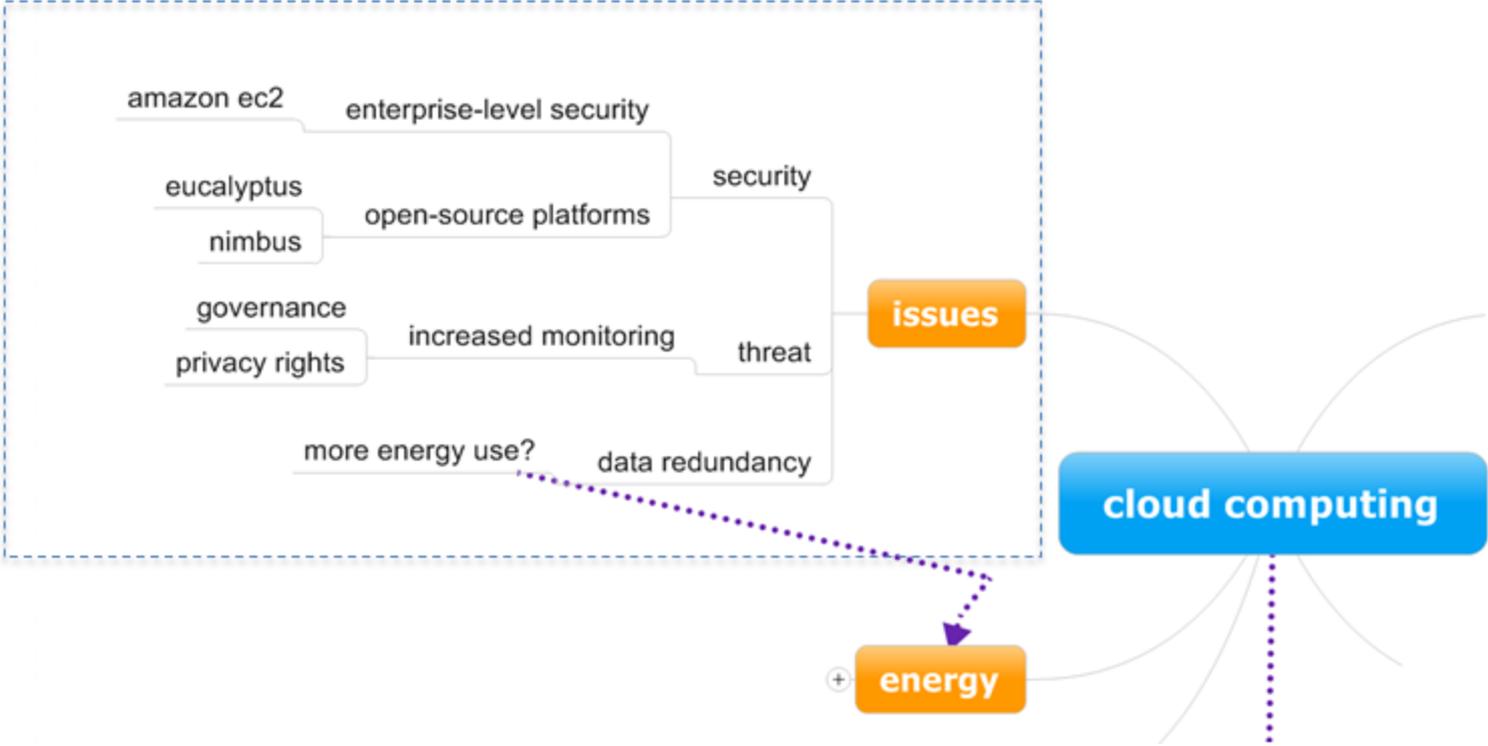
inventory of issues

cloud computing mind map

- **cloud computing** (center)
  - **issues**
    - security
      - enterprise-level security
        - amazon ec2
      - open-source platforms
        - eucalyptus
        - nimbus
    - threat
      - increased monitoring
        - governance
        - privacy rights
    - data redundancy
      - more energy use?
  - **goals**
    - ubiquitous access
    - secured access
    - location of data?
    - routing of confidential data?
  - **energy**
    - use
      - small
      - widespread
    - sources
      - renewable
      - non-renewable
  - **govt. incentives**
    - personal
    - enterprise
  - **network**
    - can we handle the bandwidth??
    - solution
      - cloud caches?
      - minimum/cheap local storage
  - **social implications**
    - affect on human behavior
      - new products
        - using hci-driven interaction design
        - increase or decrease energy use?
      - additional computing capacity
      - accessibility
      - sustainability of data
      - reliability of data
    - enterprise behavior
      - cost & efficiency of it operations
      - reliability of business
      - sustainability of data
  - **sustainability implications**
    - energy use
    - hci/interaction design
  - **climate change**

Inventory of Issues
Figure 2 shows a conceptual   d its
implications for climate char   ith
cloud computing, namely iss   ability
implications.

The figure shows six main ar   ies,
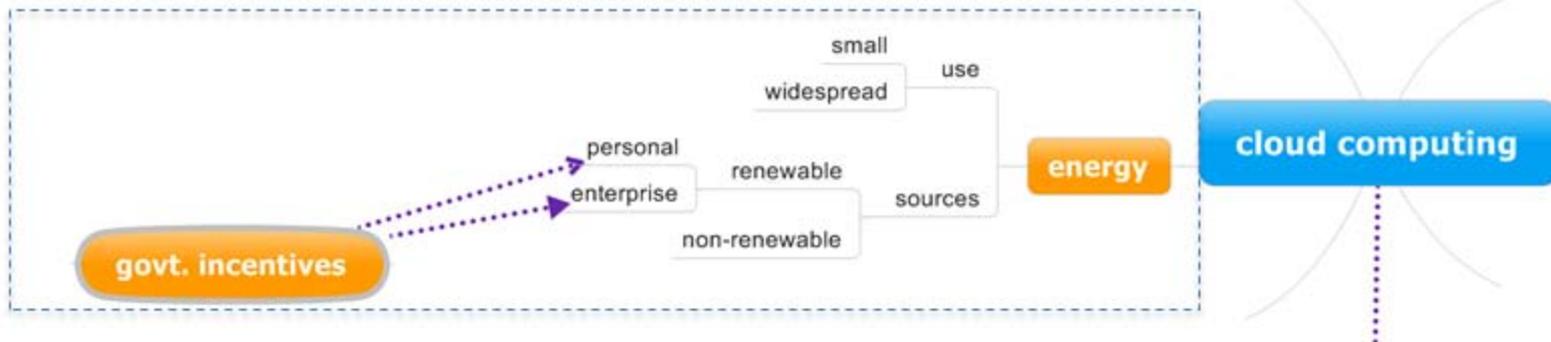energy, networks, goals, soci
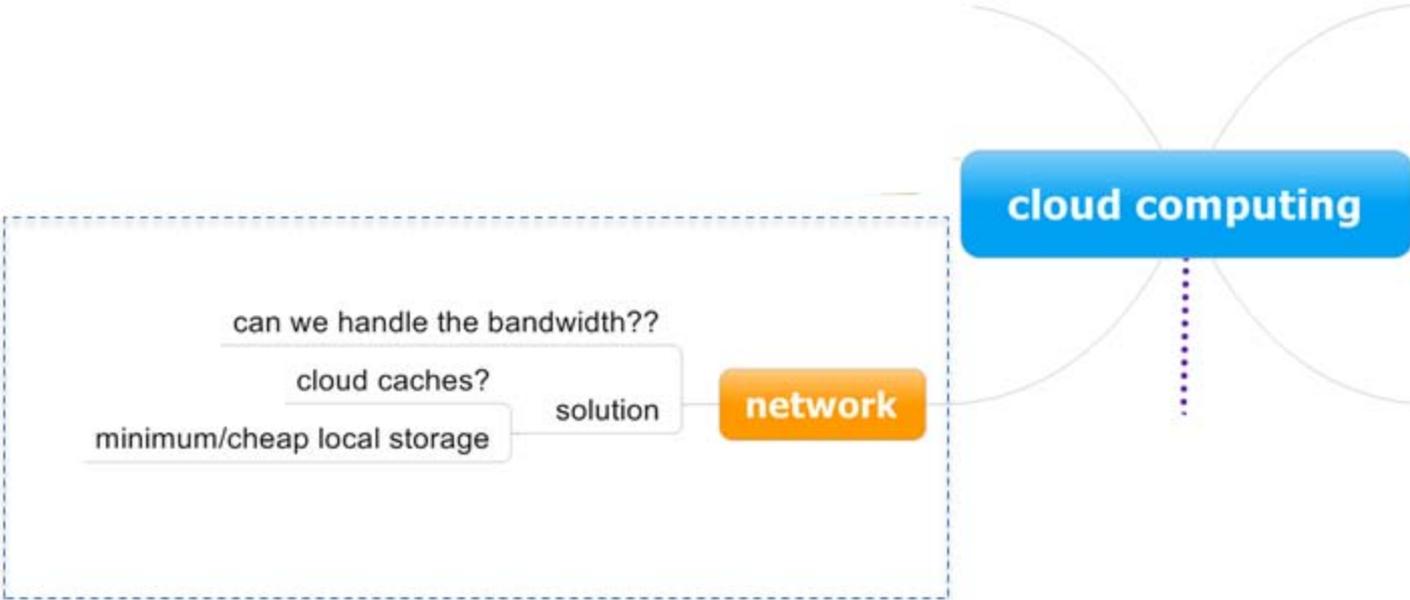
Inventory of Issu

By issues, we me

cloud computing

Eucalyptus [9] ar

and may prompt

By energy, we m

cloud computing

renewable sourc

have apropos of

delivered.

cloud computing

can we handle the bandwidth??

cloud caches?

solution

minimum/cheap local storage

network

cloud computing

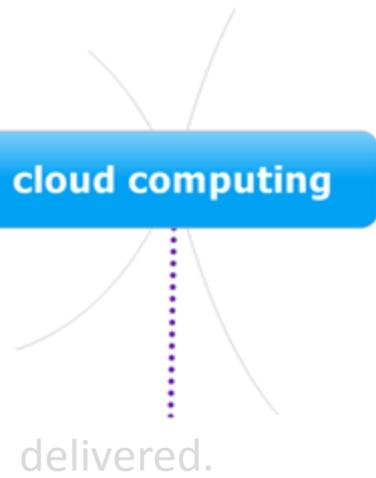**goals**
- ubiquitous access
- secured access
- location of data?
- routing of confidential data?

...ded by enterprise
...rms such as
...at to privacy rights

...idespread use of
...he use of
...omputing can
...rvices can be

cloud computing

social implications

affect on human behavior

- new products
- additional computing capacity
- accessibility
- sustainability of data
- reliability of data

enterprise behavior

- cost & efficiency of it operations
- reliability of business
- sustainability of data

delivered.

Inventory of Issue

by enterprise

; such as

privacy rights

spread use of

se of

puting can

es can be

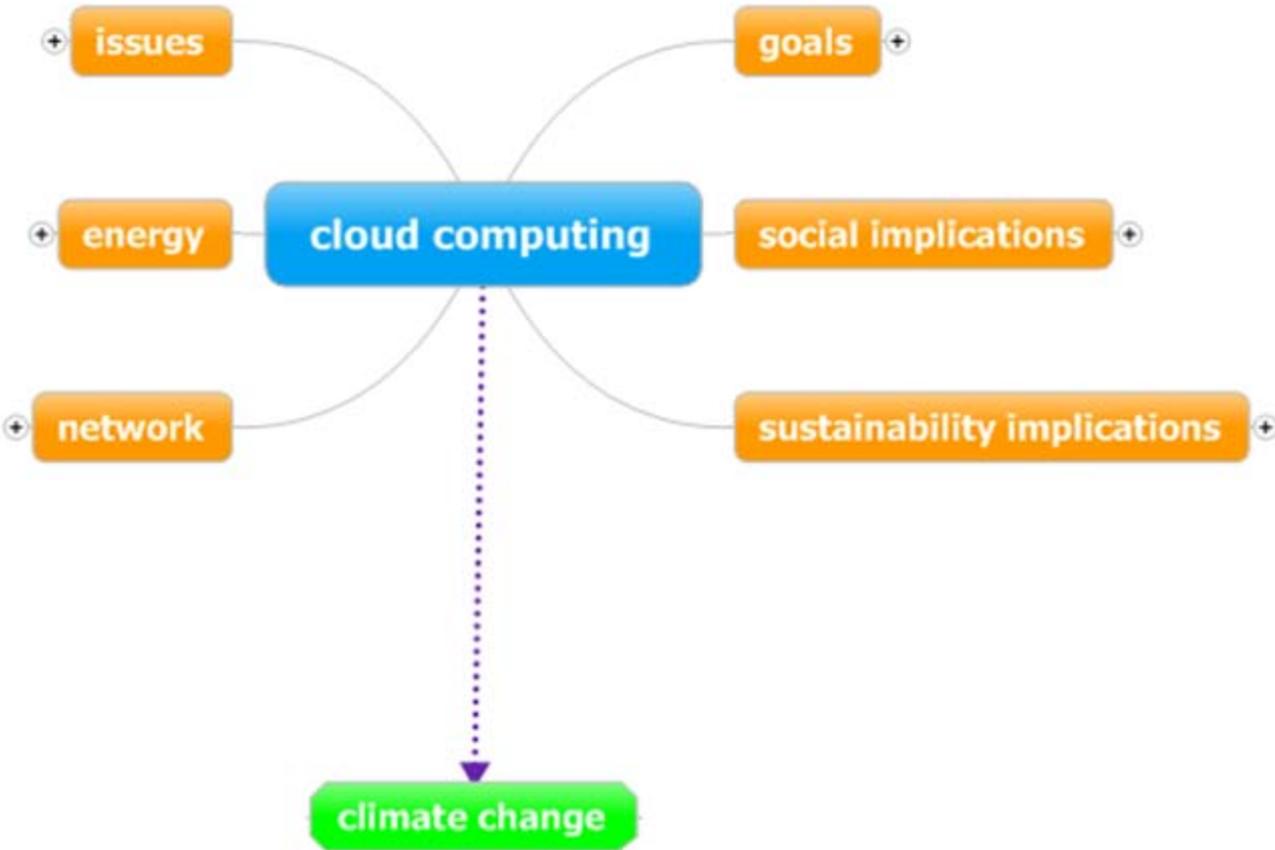cloud computing

sustainability implications

energy use

hci/interaction design

Inventory of Issue

By issues, we mean to include c
cloud computing platforms suc
Eucalyptus [9] and Nimbus [8, a
and may prompt changes in gov

By energy, we mean to include
cloud computing and the possil
renewable sources of energy. B
have apropos of energy use and
delivered.

thanks!