Our cloud is **thirsty**!

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A massive data center

- Facebook's data center in Prineville, OR

Something we know

- Data centers are energy hogs
  - Combined energy usage of all data centers would rank 5th in the world if data centers were a country
  - Tens of millions of $$$ in annual operational costs
  - Responsible for large amount of greenhouse gas emissions
  - ……

Something we may **not** know

- Data centers are very ***thirsty*** and consume an enormous amount of fresh water
  - e.g., U.S. National Security Agency's massive data center in Utah consumes **1.7 million** gallons of cooling water each day [1]
    - Enough to satisfy *1.7* million people's drinking water supplies
    - Enough to satisfy over *2,000 families'* water needs

[1] http://www.ksl.com/?sid=25978926&nid=148
[2] http://www.datacenterknowledge.com/archives/2009/04/09/data-centers-move-to-cut-water-waste/

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"**Water** is tomorrow's big problem," but "no one talks about water." [2] --- James Hamilton, Amazon VP

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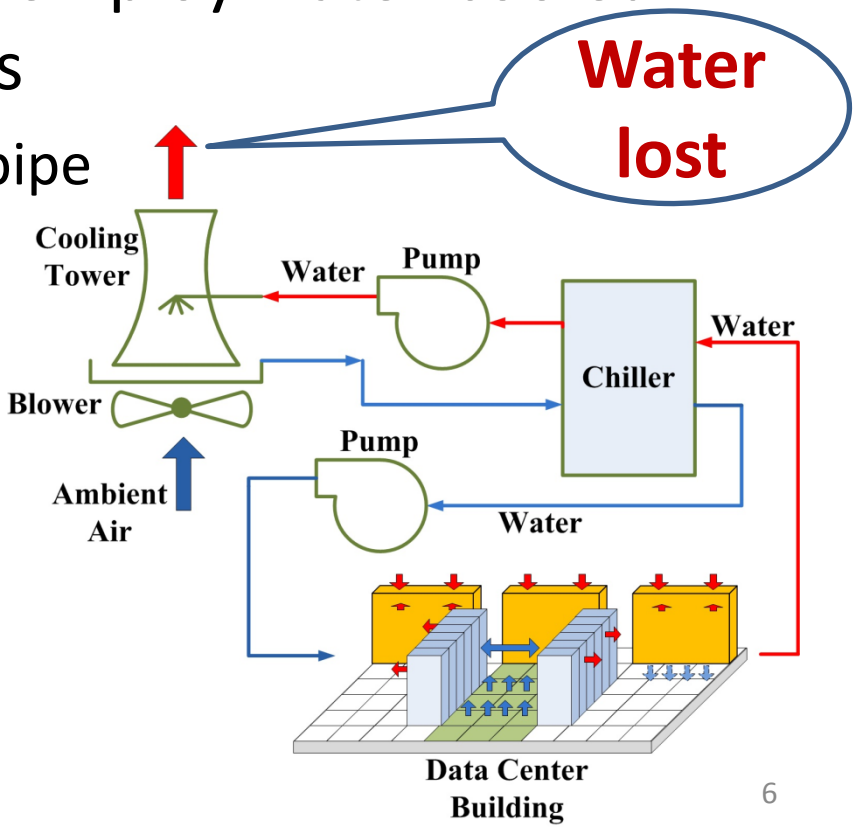
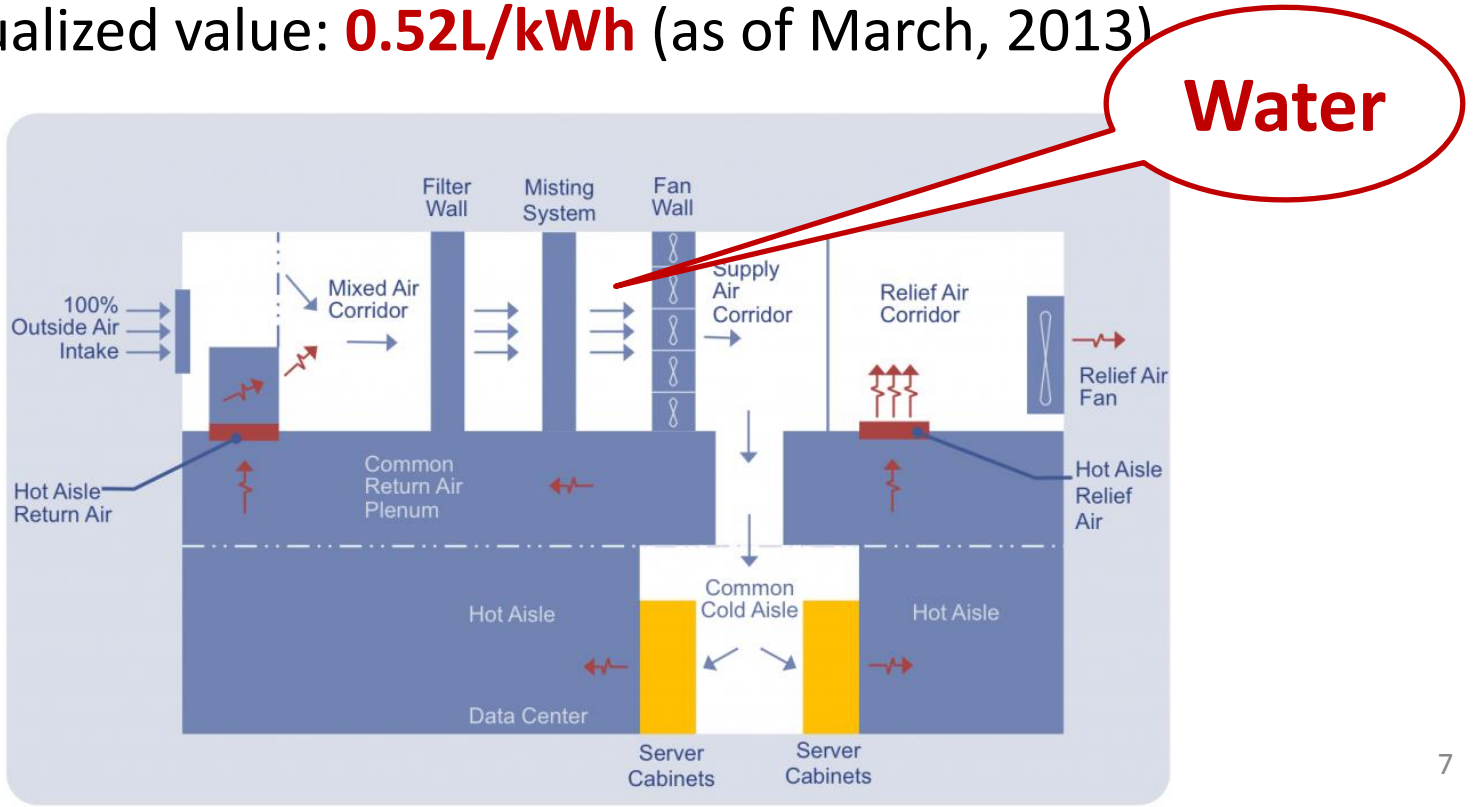
Why does data center consume water?

- Water evaporation is a very old but effective mechanism to remove heat
- ***Large*** data centers typically employ water-cooled chillers to cool down servers
  - Chilled water flows through pipe and cools down the air
  - Warm water returns to cooling tower and ***evaporates*** to remove heat



Are cooling towers required?

- Facebook's data center in Oregon does not use cooling towers but still consumes huge amount of water!
  - Combine cold outside air with evaporative cooling
  - Annualized value: **0.52L/kWh** (as of March, 2013)



Just wait a moment…

- Data centers also consume water ***indirectly***
  - Data centers use electricity, but generating electricity consumes a **huge** amount of water
    - Yes, literally "**huge**"!!
    - Hot water steams needs to cool down in cooling towers for thermal and nuclear electricity; hence, water **evaporates**
    - Over 90% electricity is thermal in the U.S.
    - Water withdrawal by electricity generation accounts for over **40% (Top 1)** of total water withdrawal in the U.S.
    - U.S. national average, 1.8L/kWh water consumption [3]

[3] http://www.thegreengrid.org/~/media/WhitePapers/WUE

Hence…

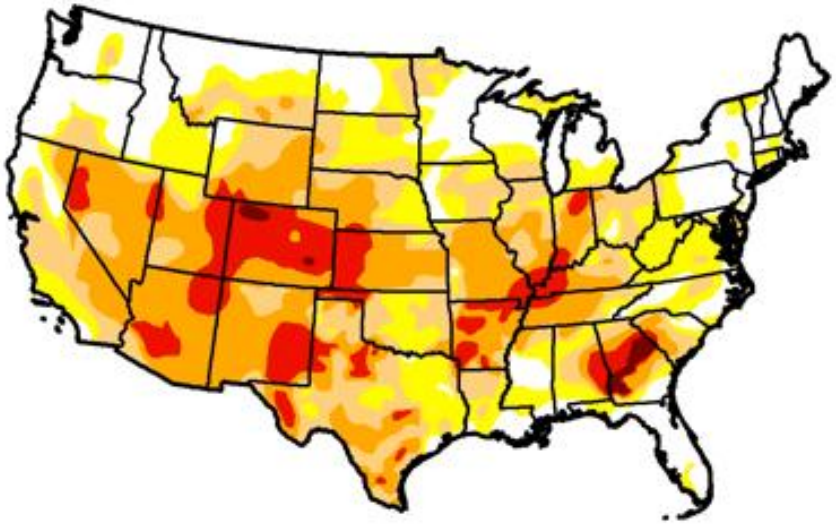
- As data centers are held responsible for carbon emissions, they must also be responsible for ***water*** consumption in electricity generation
- In parallel with the well-known PUE, **Green Grid** develops an emerging metric **Water Usage Effectiveness (WUE)**

$$\text{WUE} = \frac{\text{Onsie Water} + \text{Offsite Water}}{\text{IT Energy}}$$

Well, data centers are ***large*** water consumers, but is it critical to reduce the water footprints?

Why do we care about water?

- Data centers' huge water footprints have...
  - Worsened global droughts and water shortage



  - Increased pressures on local water supplies
    - Northlake, IL, has to find additional water resources for Microsoft's data center [4]

[4] http://www.datacenterknowledge.com/archives/2008/08/20/northlake-buys-extra-water-for-microsoft-site/

Some may have concerns…

- Water is so cheap (compared to electricity)
  - It may ***NOT*** be in the future!
  - ***"Cap-and-trade"*** is being actively discussed for large water consumers (incl. data centers), and excessive water usage will face heavy charges [5]
  - Corporation's public image… Facebook is taking the lead to report its real-time water usage!
- Water will eventually return to the earth…
  - But, it may return to the ocean or get polluted
  - Getting evaporated/polluted water back to "fresh and clean" is really difficult, and this is partially why we see ***"Save Water"*** everywhere!

[5] http://web.mit.edu/12.000/www/m2012/finalwebsite/solution/groundwater.shtml

Some may still have concerns…

- Reducing electricity consumption will also reduce water consumption, so there's no need to consider water separately?
  - Water and energy are related but also different!
    - Simply minimizing the energy may not necessarily lead to effective water reduction, because different energy fuel sources consume different amount of water (just as different energies are priced differently)!
  - Cooling water efficiency changes over time and over locations

What has been done?

- Surprisingly and also embarrassingly, ***very little***
- ***Existing efforts***
  - Using cold outside air, a.k.a. "**free** cooling"
    - Google has a data center in Dublin
    - But, only applicable for cold regions
  - Using recycled/sea water to reduce drinking water consumption
    - May consume more energy and increase offsite water consumption
    - Requires millions of dollars' capital investment!
  - **Media attention**
    - Just Google "data center water consumption"

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Offsite water consumption is neglected!

  - **Media attention**
    - Just Google “data center water consumption”

Can we do something ***else*** to reduce data centers' water footprints?

- Considers both onsite and offsite water consumption
- Requires no huge capital investments
- Easy to implement

It’s time to look at *water!*