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Smart Water Grid

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Background

- Four-year project at ASU to analyze sustainable and resilient energy and water infrastructure for Phoenix, including energy/water nexus
- John Crittenden (PI) + 5 faculty + 6 graduate students
- Supported by National Science Foundation
- Not developing technology but trying to understand how to put technologies together to achieve benefits at reasonable cost.
- Started working on smart water grid ~ Oct 09 (caveat)

Smart Grid Comparison: electric versus water

Components of Smart Electrical Grid	Analogous Components of Smart Water Grid
Smart electrical meters	Smart water meters
Decentralized renewables: wind and solar	Decentralized water treatment/distribution/
Efficient home/business electrical management	Efficient home/business water management
Detection and improvement of power quality	Detection and improvement of water quality

Smart Water Grid Scales

- Treatment plants
- Distribution system
- Users:
  - Industry
  - Agriculture
  - Residential

What to address with smart water grid?

- Water demand – users usually use more water than needed to realize “service” delivered
- Water leaks – 10-20% of water lost in distribution, difficult to detect underground leaks
- Automate meter reading/data collection
- Checking water quality from treatment plant to tap

Technology element: smart water meter

- Smart water meters can:
  - Be networked
  - Record real time data
  - Do sophisticated information processing
- Challenges:
  - How to power: many meters not next to power line
  - Expense
- Potential solutions
  - battery/solar/low power mesh networks
  - Advanced processing to reduce number of meters

http://www.outpostcentral.com/english/ProductLiveWaterMeter.aspx

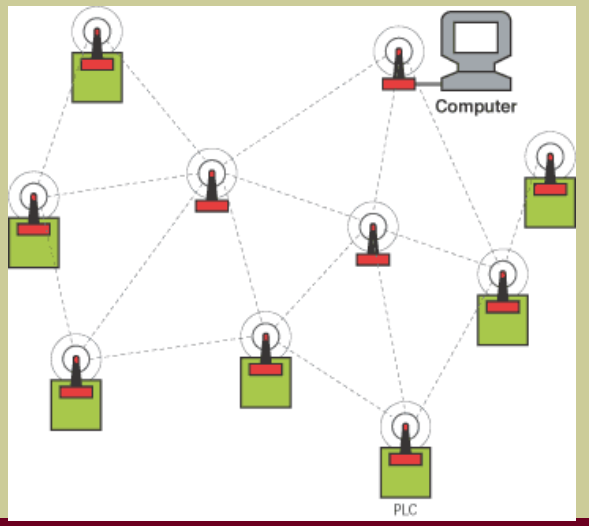
http://www.minsenmeter.com/product_SHOW.asp?product_id=137

Powering and networking water smart meters

- When not near electrical line, can use solar/motor, storing with lithium battery
- Low power network achievable with mesh-network concept: signal need only reach nearest nodes,

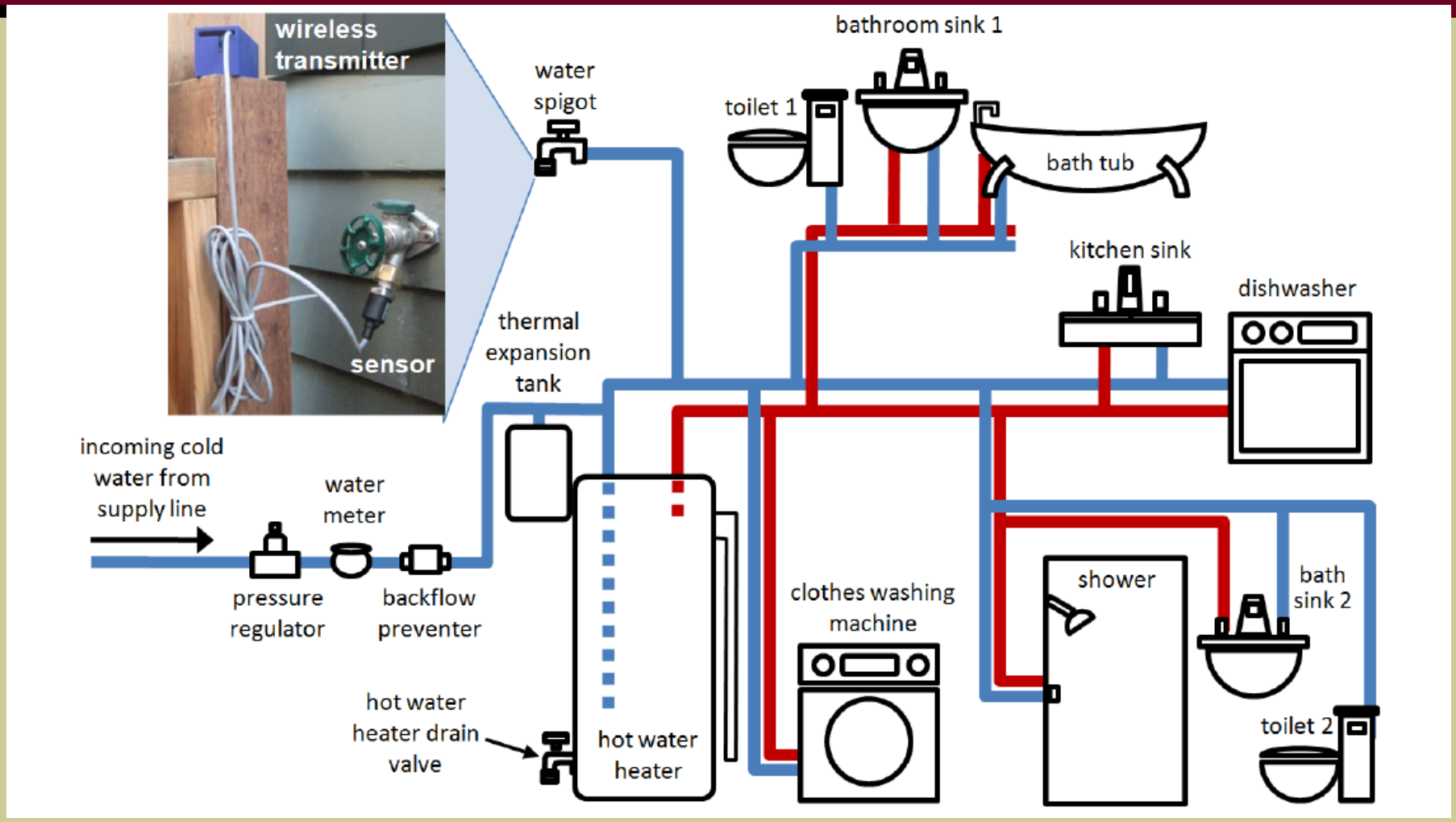
e.g. Zigbee protocol

Solar-powered smart water meter
Source: Hauber-Davidson and Idris (2006



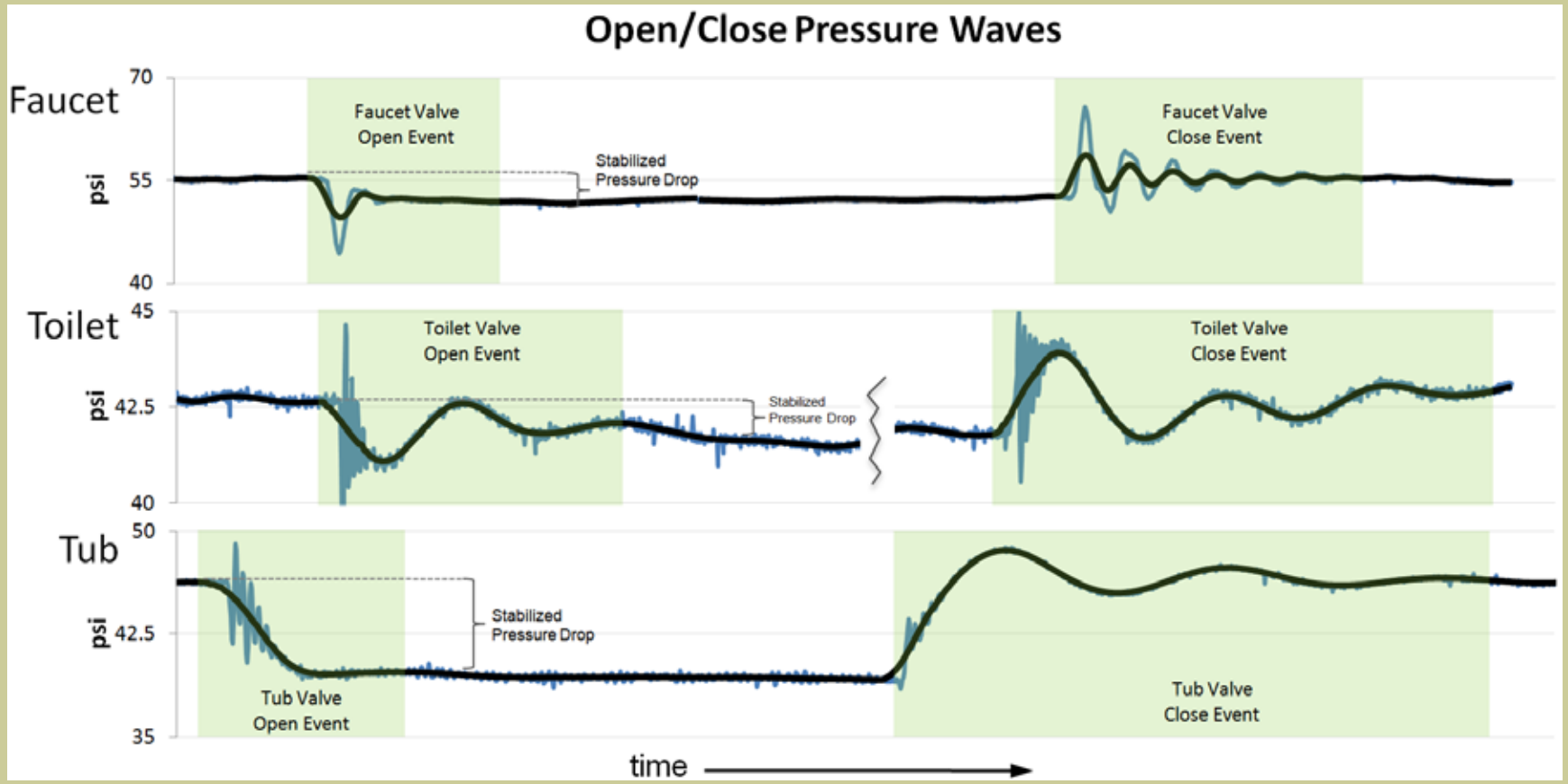
Topology of a mesh network

Advanced processing: Hydro Sense System



Source: Jon Froehlich et. al. U. Washington (2009)

Case Study: HydroSense Single-Point Sensing of Home Water Activity



Source: Jon Froehlich et. al. U. Washington (2009)

Application: advanced controllers reducing landscape water use

- Evapotranspiration (ET) Irrigation controllers use sensors, site information, and weather data to give landscapes the proper amount of water.
- Various systems commercially available
- Study in Las Vegas showed 26% average outdoor water savings (including desert climate/plants) without compromising plant health

Assessment: potential to reduce water use in Phoenix

Water implications	Annual Water Saved	Equivalent Amount of Water
ET controller in a single-family home, City of Phoenix, 2000	28,000 gallons	17% of total household water consumption
ET controller in all single-family homes, City of Phoenix, 2000	25,000 acre-feet	2% of municipal PAMA demand (1998)
ET controller at all turf facilities (golf courses)	25,000 acre-feet	1% of total PAMA demand (1998)

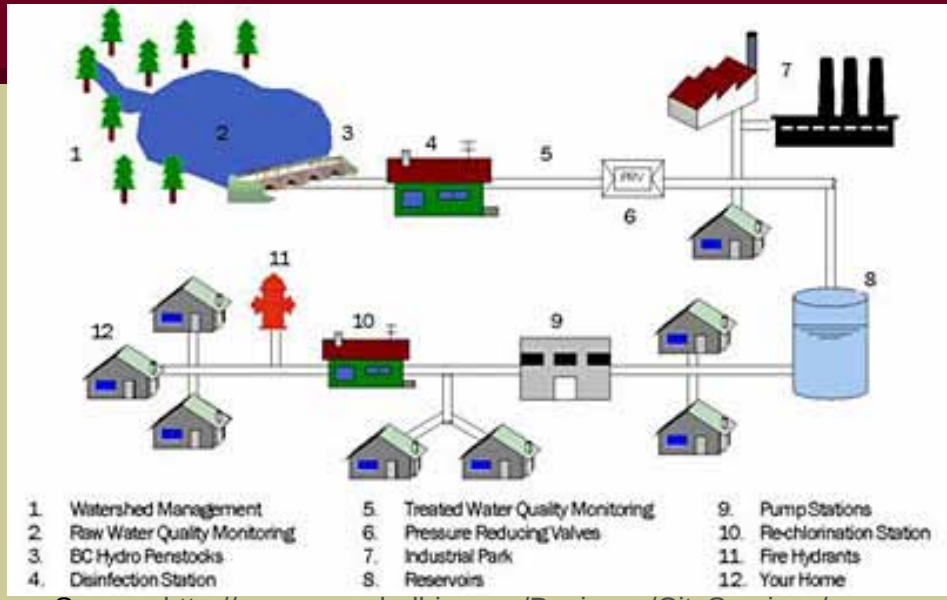
Price range of controllers (2004) is $99 to $485. In addition some have annual service costs

An average of $56/year can be saved on a Phoenix consumer water bill from installing an ET controller.

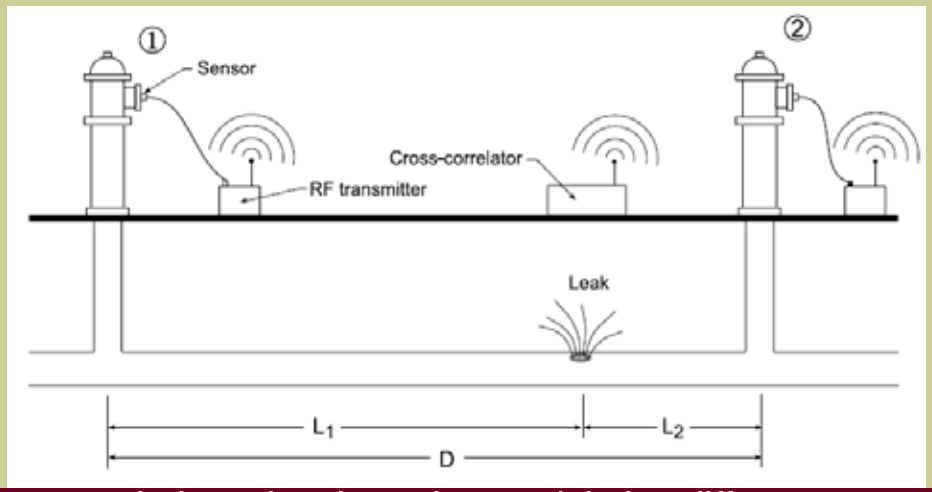
Source: Mutchek and Williams, in preparation (2010)

Application: identifying leaks

- Current system: monitored after treatment, then at end users (monthly or greater aggregates)
- ~10-20% losses in leaks
- The big question: do new technologies enable a different paradigm in detection?

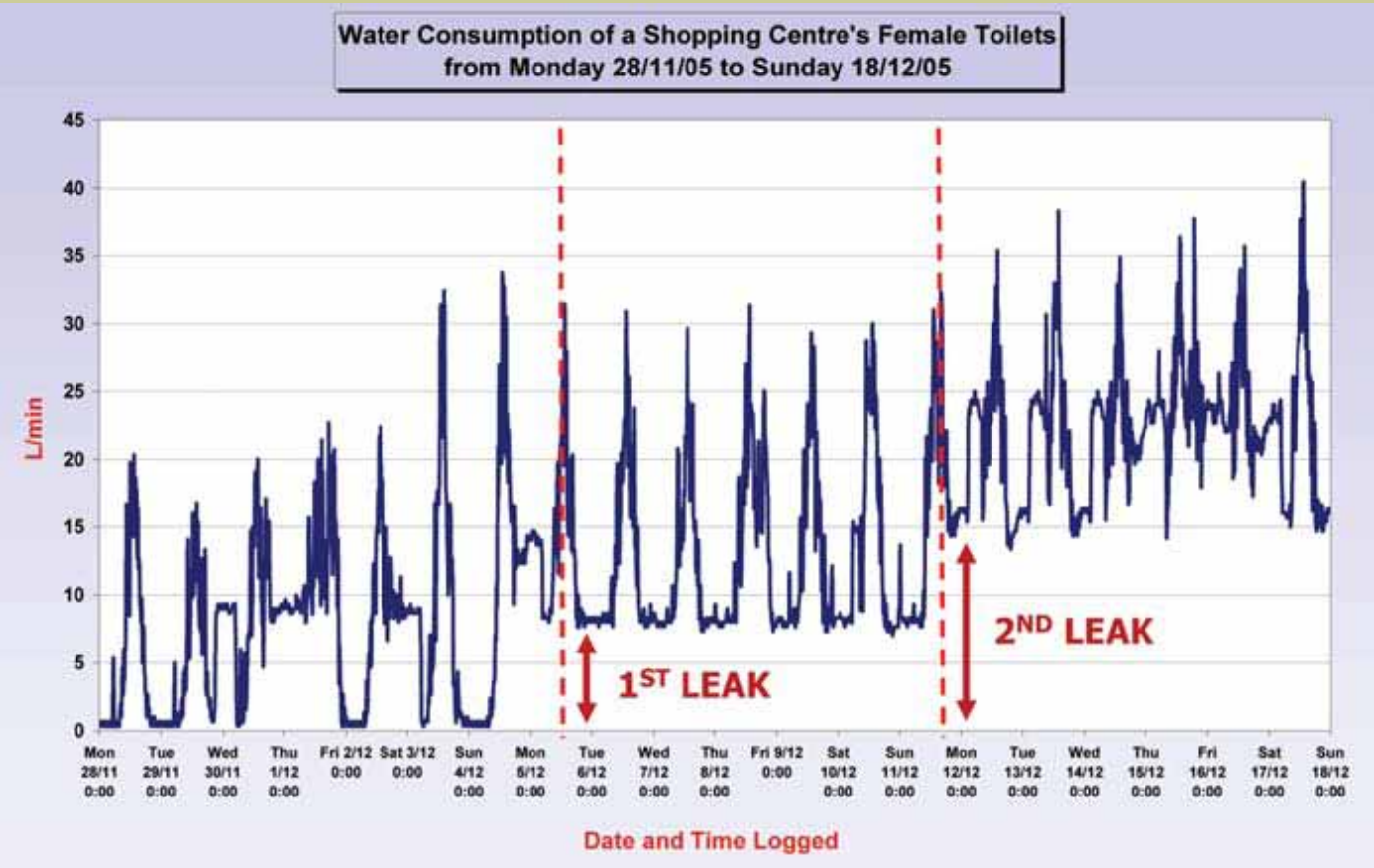


Source: http://www.campbellriver.ca/Business/CityServices/WaterSupplyandDistribution/Pages/SupplyandDistribution.aspx



Leak detection through sound timing differences
Source: Hunaidi (2000)

Application: Identifying leaks with Smart meters in shopping mall



Source: Hauber-Davidson, et. al. 2006

Future Direction

- Next steps:
  - Finish up evaluation of evapotranspiration (ET) Irrigation controllers
  - Develop clearer vision of water smart grids needs and solutions
  - Research on identified priorities
- Hope for feedback/input from experts here

Questions/ comments?

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