The Internet of Water: How Improved Water Infrastructure Can Answer Fundamental Questions

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Water Mission Area
U.S Geological Survey

Water issues abound

as society puts increasing pressure on limited freshwater resources

Image credit, left to right: Time Magazine (left and center images) and National Geographic Magazine

Where can you find water data?
What's the best source?

Finding relevant water data can be challenging.

Hundreds of federal, state, local, tribal and other monitoring organizations collect water data. Many fundamental questions about water cannot be answered.

- Different delivery media (websites, web services, by email, through the mail, and more)
- Different delivery format (PDF, CSV, JSON, scanned documents, and more)
- Different data and metadata formats (units, geospatial references, time/date, and more)
- Different measurement methods (discrete, continuous, analytical, remotely sensed, and more)

The Federal Open Data Movement

Implications for Water Data

Timeline

2013 Presidential Open Data Policy

2014 Federal Climate Data Initiative

2015 Federal Open Water Data Initiative

2017 Internet of Water Report

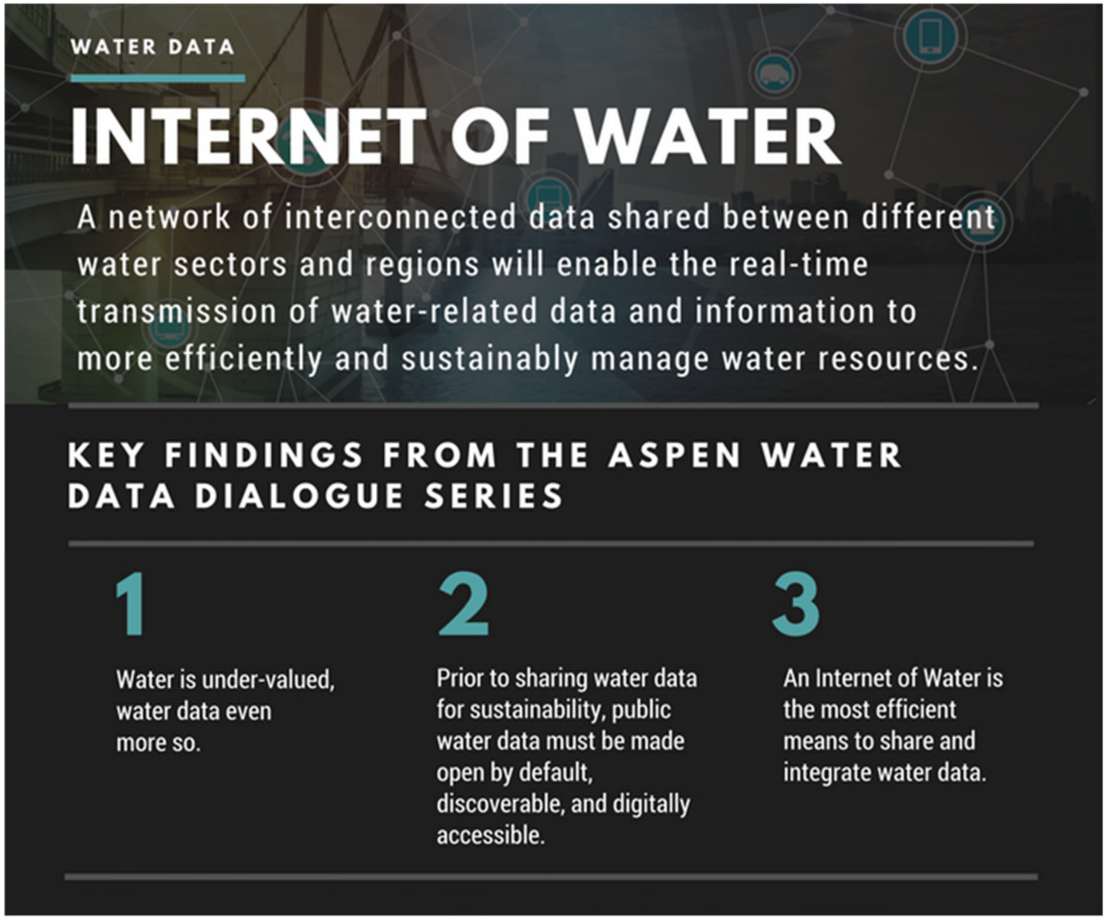
Credit: https://www.aspeninstitute.org/publications/internet-of-water/

Internet of Water

A report from the Aspen Institute

Findings:

1. The value of open, shared, and integrated water data has not been widely quantified, documented or communicated.
2. Making existing public water data open is a priority.
3. The appropriate architecture for an "Internet of Water" is a federation of data producers, hubs, and users.



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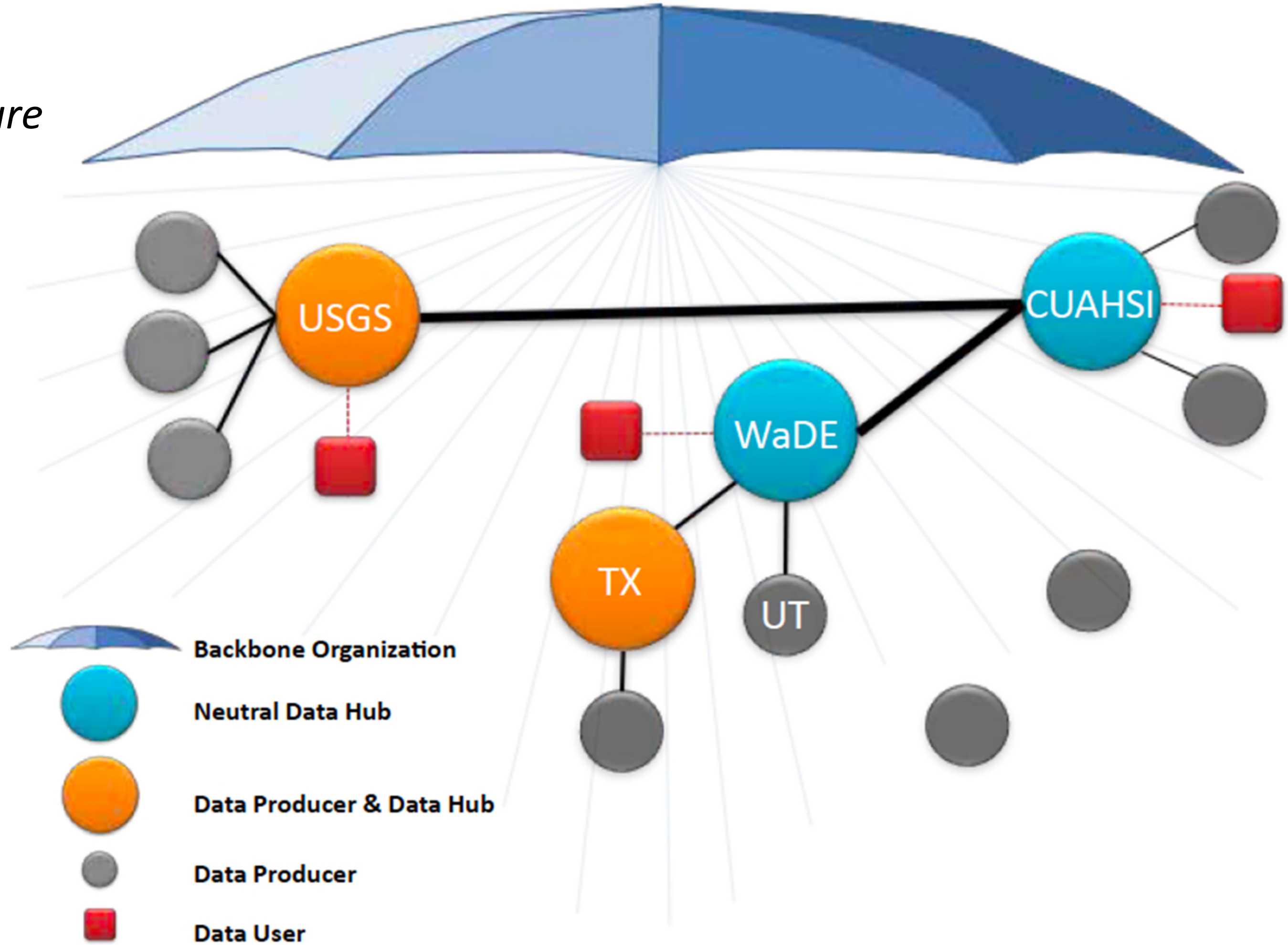
Internet of Water

Appropriate architecture



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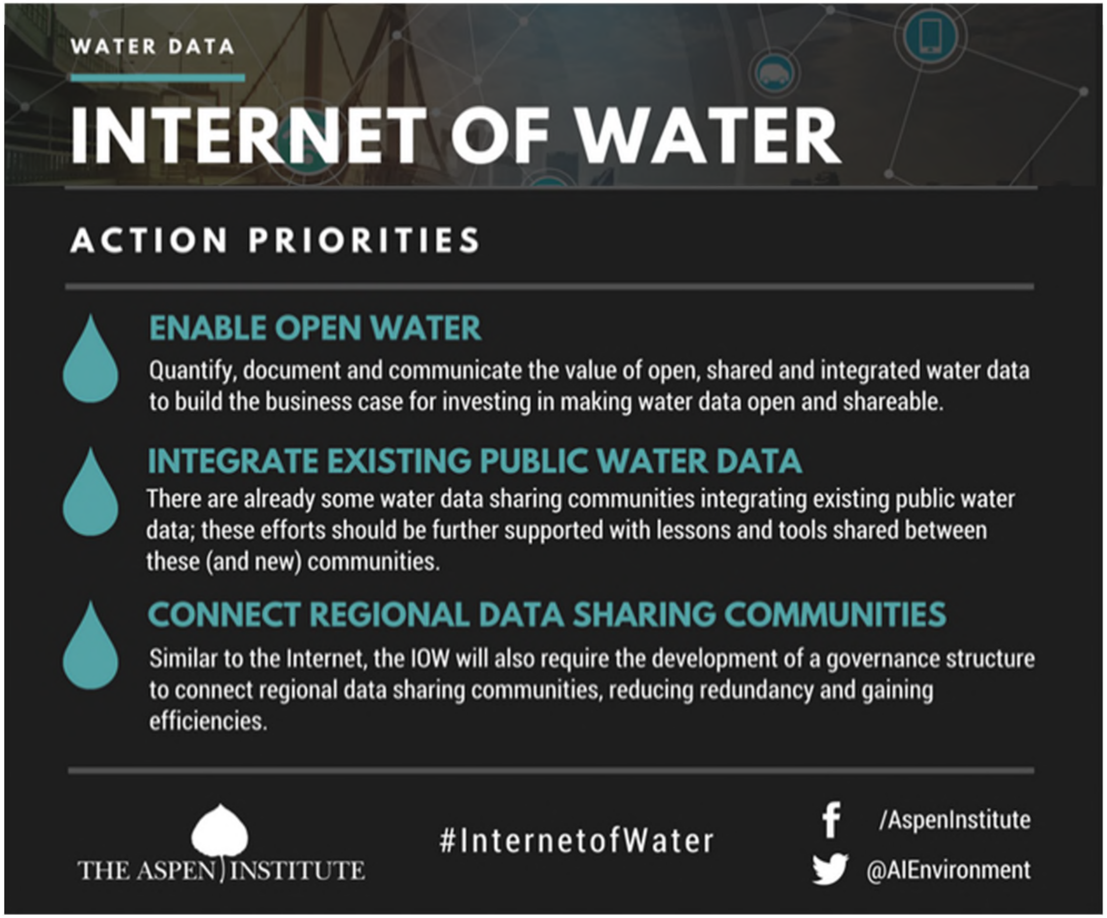
Recommendations:

1. Articulate a vision
2. Enable open water data
3. Create an Internet of Water



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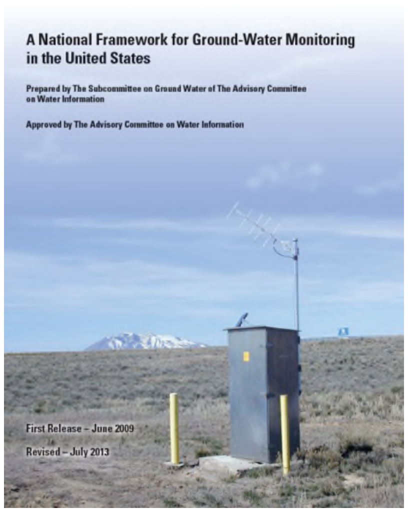
IoW Recommendation 2.2: Develop tools for opening existing, public water data and enable the use of those tools by producers and users.

NGWMN Goal

To create a single publicly accessible, automated data portal to relay groundwater quantity data, groundwater-quality data, and associated metadata from distributed databases through a map-based graphical user interface.



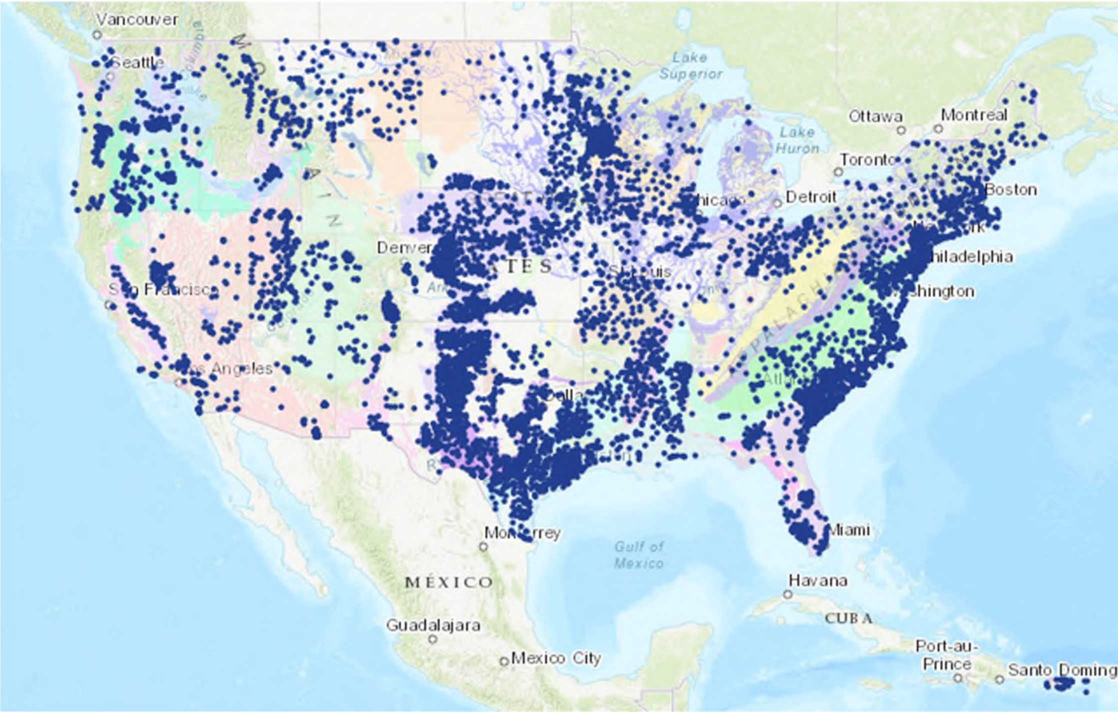
NGWMN Design Elements

- Principal and major aquifers
- GW levels and quality, focus on availability
- Priority on sites with long-term data
- Network, not a Warehouse or Master Database
- Willing data providers: State, Federal, Tribes, others
- Sites classified by local experts/data providers, and selected sites become part of the Network
- Data provider is the authoritative data source
- Data available to all without restriction or cost

Current Status

28 Contributing Agencies

- 7,129 water-level wells
- 1,922 water-quality wells
- 63 principal aquifers
- 10 subnetworks



Data Provider Pages

https://cida.usgs.gov/ngwmn/provider/UTGS

National Ground-Water Monitoring Network
Utah Geological Survey (UTGS) Data Provider Information

UTAH DNR GEOLOGICAL SURVEY

Link to: Utah Geological Survey Groundwater Information

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The Utah Geological Survey maintains a water-quality monitoring network that consists of both wells and springs. The network began as a NGWMN water-quality pilot project in 2014 with support from the USEPA. Sites are collected annually and are analyzed by the USEPA Region 8 Laboratory in Denver.

Principal aquifers monitored include the Basin and Range basin-fill aquifer, Basin and Range carbonate-rock aquifers, and Colorado Plateau aquifer.

NGWMN Progress Reports:
Final report from initial NGWMN project, July, 2015 to July 2016

Current NGWMN Projects:
2016 Round 1: 7/1/2016-6/30/2016
Project to support maintenance of database connections to NGWMN portal
2016 Round 2: 8/14/2016-8/13/2018
Project is to fill site-information gaps and perform well maintenance work. Survey grade GPS locations and land-surface altitudes will be determines at all sites and well construction details will be verified. Gap filling will also include entry of historic water-quality information from paper files and spreadsheets into the agency database. Well maintenance work is to pump 8 monitoring wells to verify the connection between the wells and the aquifer.

NGWMN Presentations:
December 2016 presentation to SOGW

Site Selection and Classification | Data Collection Techniques | Data Management | Other Agency Information

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Site Selection and Classification

Utah Geological Survey
Site Selection

For the UGS Network, we selected wells and springs in the principal aquifers of Utah (Basin and Range basin-fill aquifers, Basin and Range carbonate-rock aquifers, and Colorado Plateau aquifers) and "other aquifers" that support withdrawals of regionally significant quantities of water. Three important areas that fall into the "other aquifers" on the national aquifer map (U.S. Geological Survey, 2003) are the Navajo Sandstone aquifer in the St. George region (significant also as a state-bounding aquifer), the karst aquifers of the southern Uinta Mountains in Ashley National Forest, and the valley-fill aquifers in the Middle Rocky Mountain Physiographic Province (intermontane basins), which provide much of the water to steadily growing rural "Wasatch Back" (a local term for communities situated east of the more populous Wasatch Front of the Middle Rocky Mountains) water users (similar to the National aquifer system of the Northern Rocky Mountain Intermontane Basins in Montana). We also sampled springs and wells (some of which are monitor wells established by the U. S Geological Survey during the 1970s) in the Uinta Basin, which is within the Colorado Plateau aquifer system and an active hydrocarbon-producing and hydraulic fracturing region.

We chose to include wells and springs from the existing UGS Network. To ensure future accessibility, most of the wells in this network are regularly pumped; they include privately held water sources for consumptive use, irrigation wells from farms and ranches, and public water sources for fish hatcheries. We chose wells with lithologic logs or sufficient aquifer information to ensure that they are representative of the aquifer of interest. We only incorporate a public water supply source into the network if it was the only representative, accessible well in the area or sampled infrequently for limited water quality chemistry (i.e., just nitrate and/or sulfate every few years), and only if the location is widely publicly known and allowed to be disclosed.

Most of the sites selected for the Basin and Range carbonate-rock aquifers are springs because they are the major water source emanating from these aquifers. Much of western Utah and the Wasatch Front, the most populous region of the state, are occupied by Basin and Range basin-fill aquifers, so we selected two representative water quality sites from each basin. For the Colorado Plateau aquifers, we tried to select at least one site per populated region (especially around popular and heavily traveled destinations such as Moab, an area that caters to two national parks) or per region of perceived ecological value.

Although the Pacific Northwest basin-fill aquifers and the Pacific Northwest volcanic-rock aquifers are present in the far northwest corner of Utah, they are not aquifers of significant use in the state. Therefore, we did not target these aquifers as part of the sampling network.

Site Classification

For the Basin and Range basin-fill aquifers, we assigned subnetworks on a basin-by-basin basis. Many of the Basin and Range basin-fill aquifers have undergone hydrologic research, much which is published and freely available. The USGS, in cooperation with the Utah Division of Water Rights (UDWRi), produces a yearly report summarizing the water-level status of the areas of groundwater development. We assigned subnetworks based on these published reports.

Access Data in 3 Ways

1. Data Portal

   https://cida.usgs.gov/ngwmn/

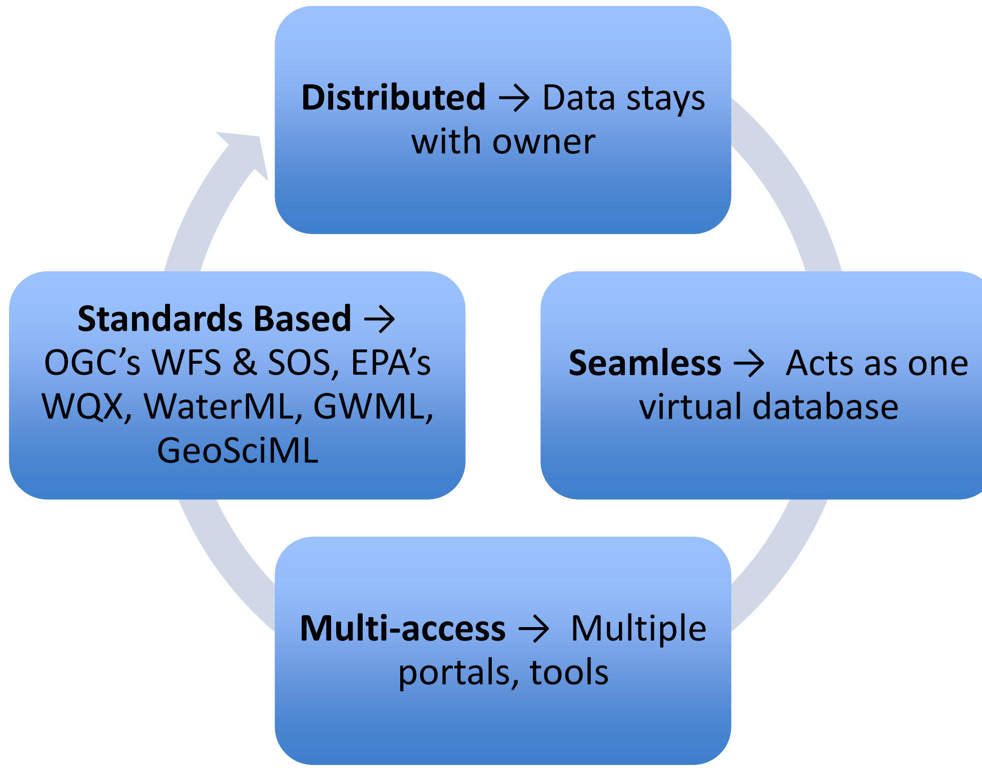
2. Web Service

   https://cida.usgs.gov/ngwmn/web-services.jsp

3. R Client

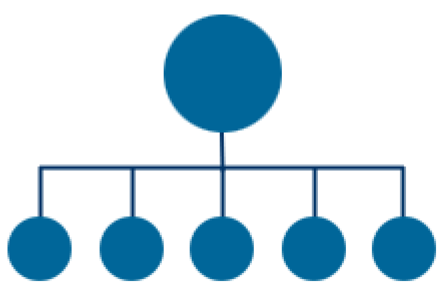
   https://github.com/USGS-R/dataRetrieval

Design Principles

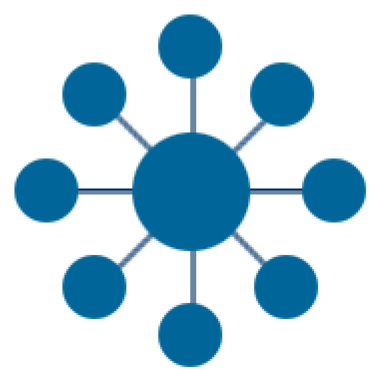


Strategy

- Implemented **hub** and **spoke** architecture
- A centrally managed well registry (**hub**) contains a minimum set of data elements for all wells
- Mediator (**hub**) transforms data from native to common format and aggregates into a single dataset
- Access state and national datasets (**nodes**) using standard protocols and mediate to common formats



centralized



hub and spoke

Hub Components:

Web Portal - Provides mapping interface to display and search wells

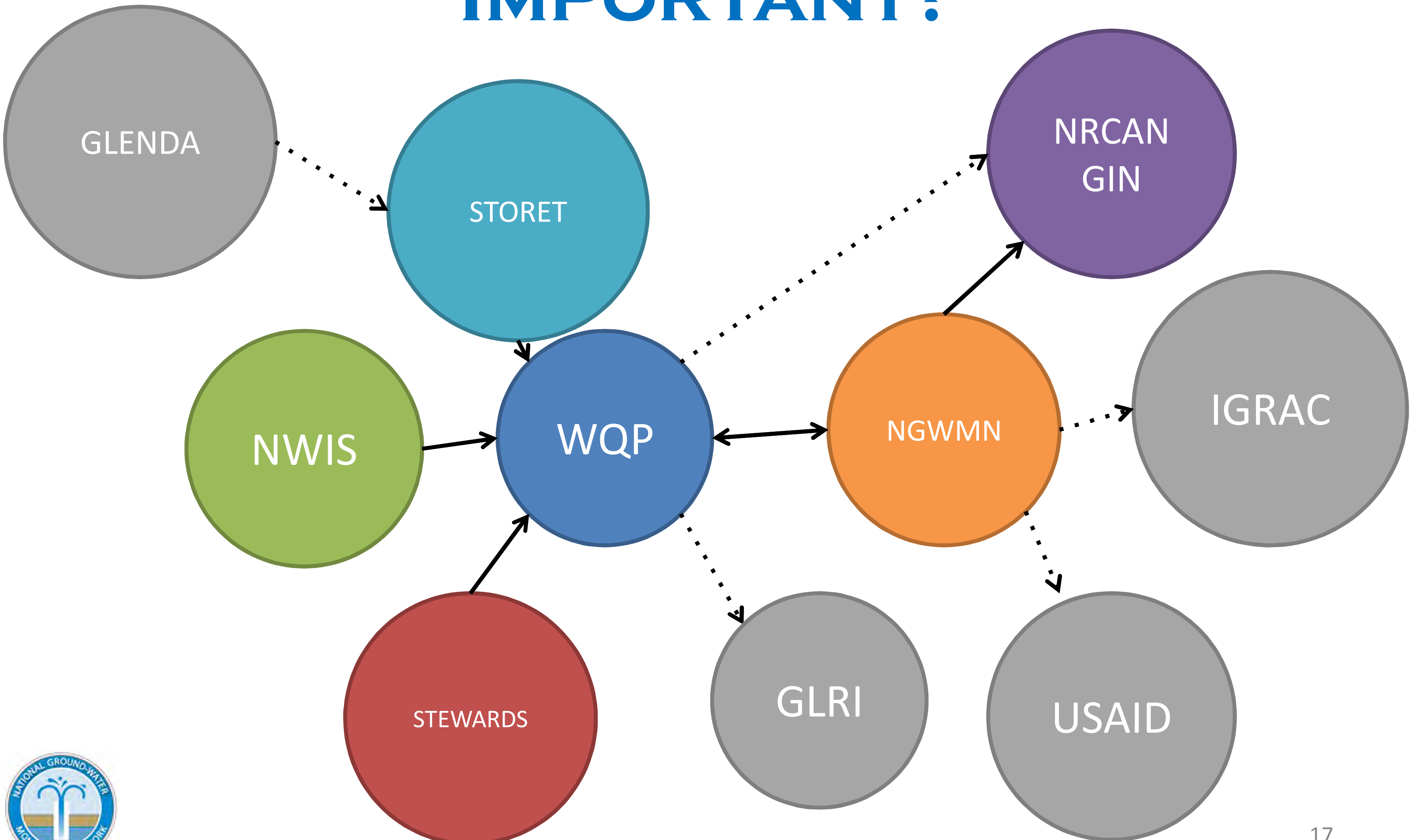
Well Registry - Harvests metadata to power web portal searching and intelligent parceling of search to nodes

Data Mediator - Collects data from each node and mediates independent formats to common ones

Architecture Advantages

- Common, inexpensive and well-supported software components for data providers
- Data providers maintain ownership of dataset and have control over which data are exposed
- Allows data providers some flexibility for implementation
- Data providers can re-purpose web services
- Integration with international groundwater community

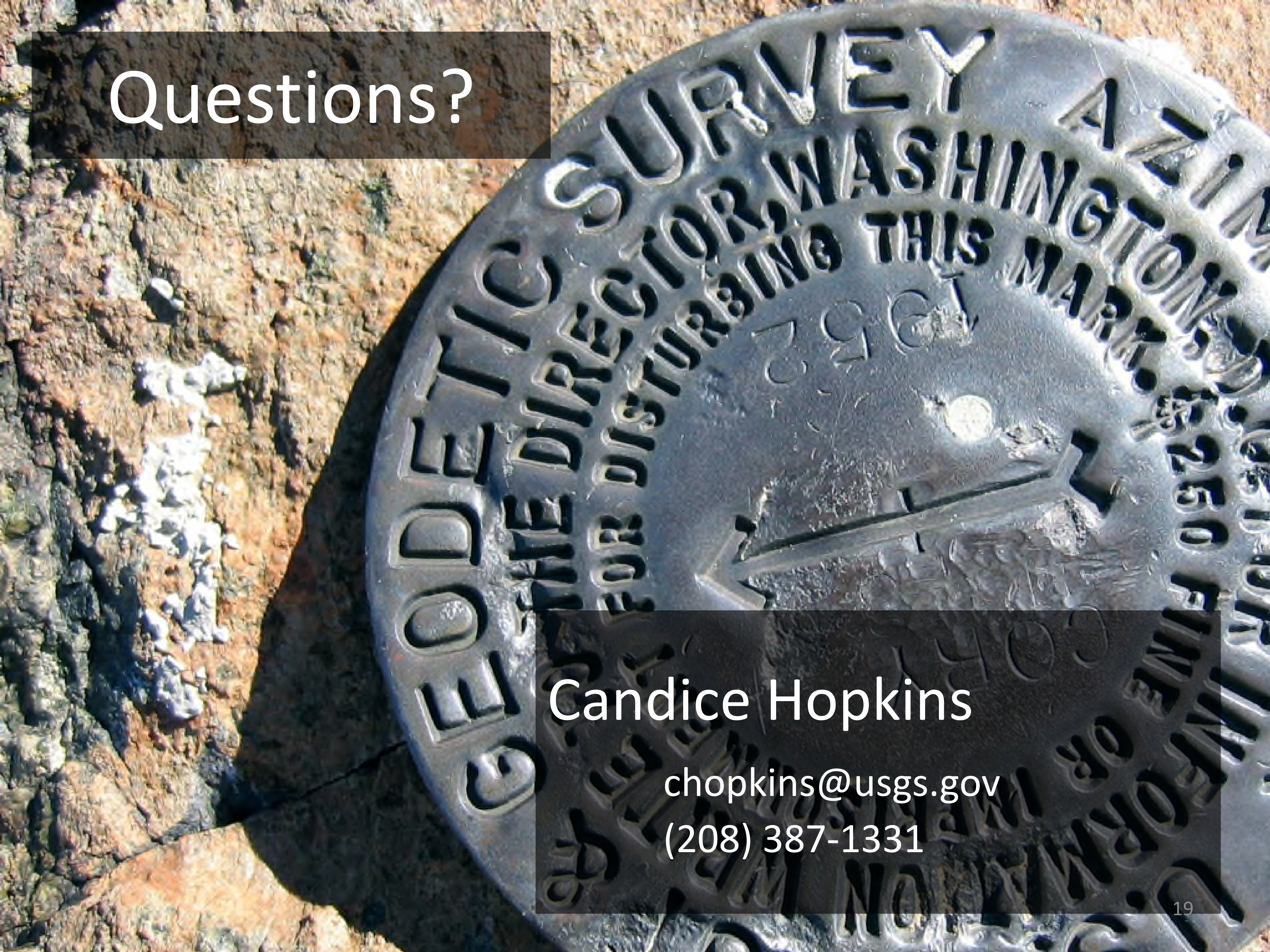
Why are Web Services Important?



Internet of Water: Next Steps for USGS

- Our Water Use group is working with the Western States Water Council and the California Water Boards to pilot a water budget for the Upper Colorado Basin (early stages).
- Indexing observations to the hydrography or to aquifers (NLDI, other methods). EPA and USGS are both contributing to this effort.
- Improving data discoverability, including improving USGS data to make more findable, readable, and interoperable.

USGS
science for a changing world



Questions?

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