WERA 1012

2024 CoCoRaHS IT Update

COLORADO CLIMATE CENTER

ATMOSPHERIC SCIENCE
COLORADO STATE UNIVERSITY

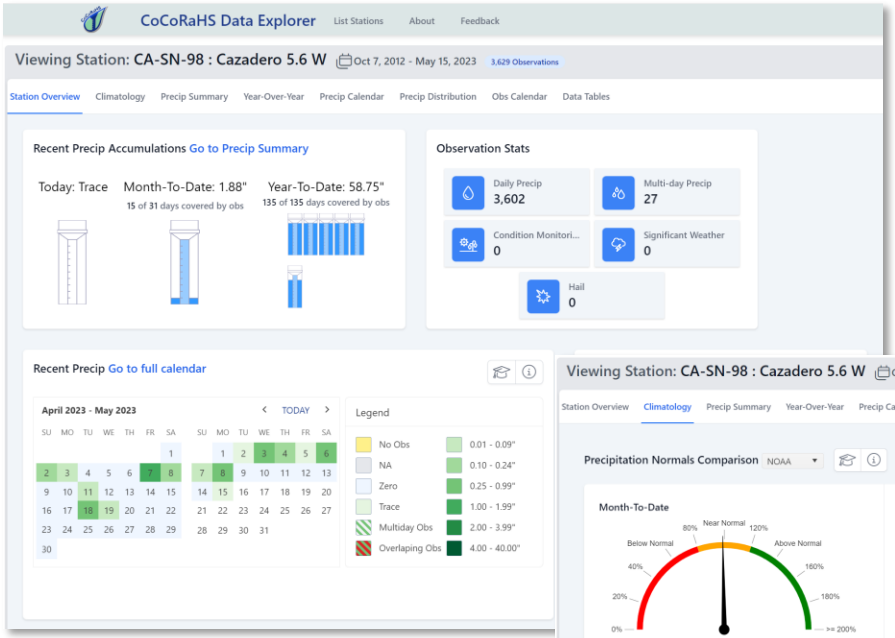
Goals for the presentation

Project Review	IT Constraints	Prioritization	Planning	Feedback
Review what has been accomplished in the last year	Discuss the constraints on IT development capacity	Discuss the approach we have taken to better prioritize projects	Review our project development plans for the coming year	Get input on which projects you would like to see us prioritize in the coming year

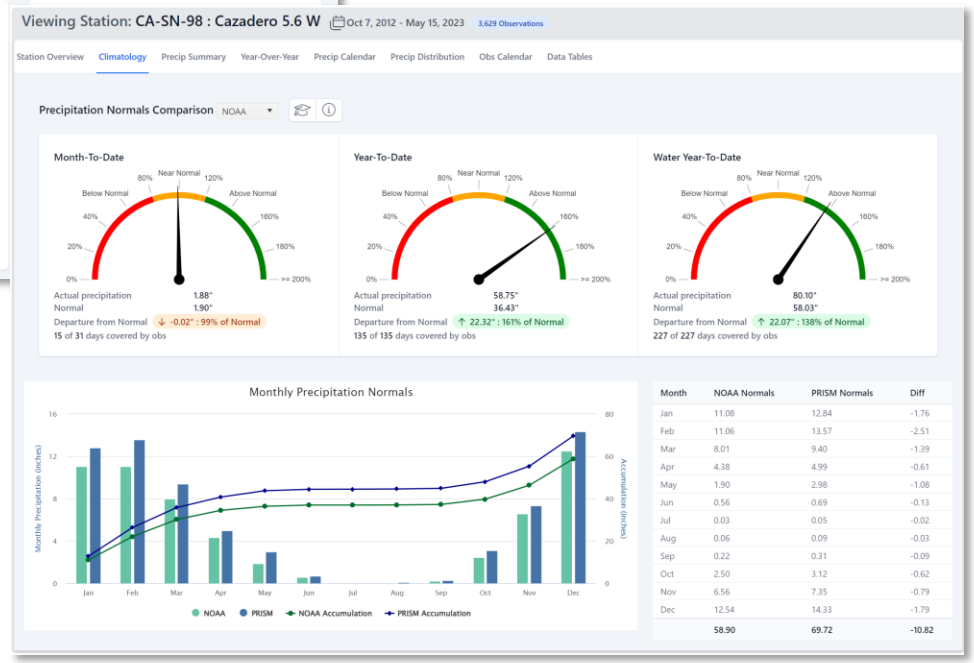
Last year's potential projects

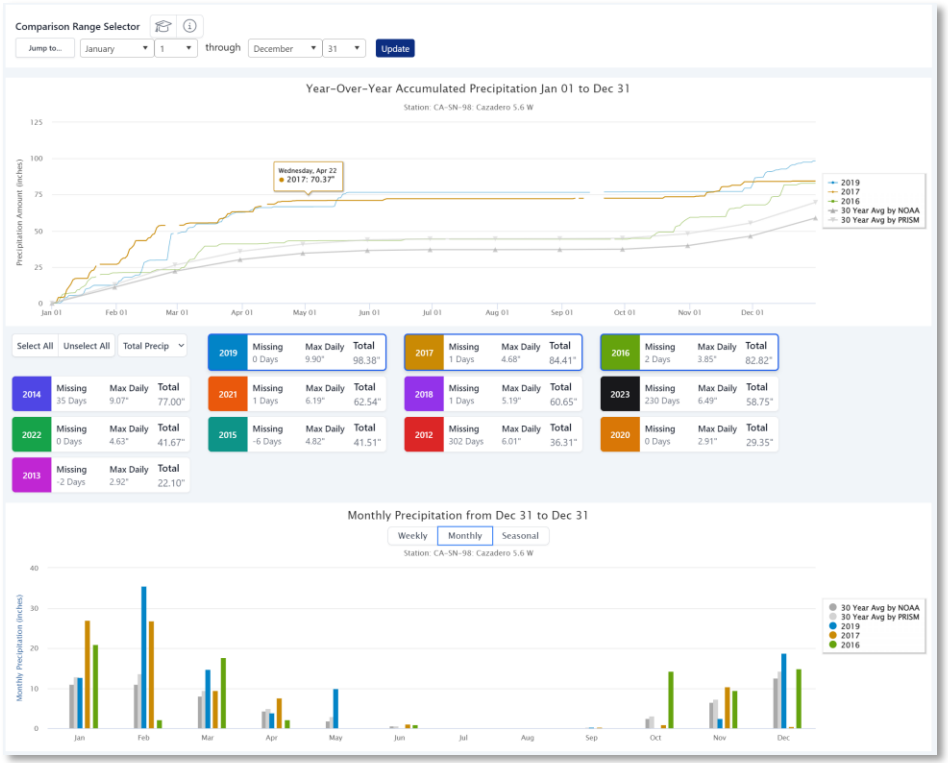
- **Finish V1 of Data Explorer**
- **Develop Mobile App Solution**
- Photo upload
- Ice Accretion
- Vector Mapping System
- Build out mobile.cocorahs.org to have feature parity with www.cocorahs.org
- Incrementally update www.cocorahs.org to function like mobile.cocorahs.org
- Station Metadata
- QC Ticketing System
- Expand upon the Data Explorer
- Build out the Databricks Data Lakehouse for complex data analysis and ML applications

CoCoRaHS Data Explorer (DEx)



dex.cocorahs.org





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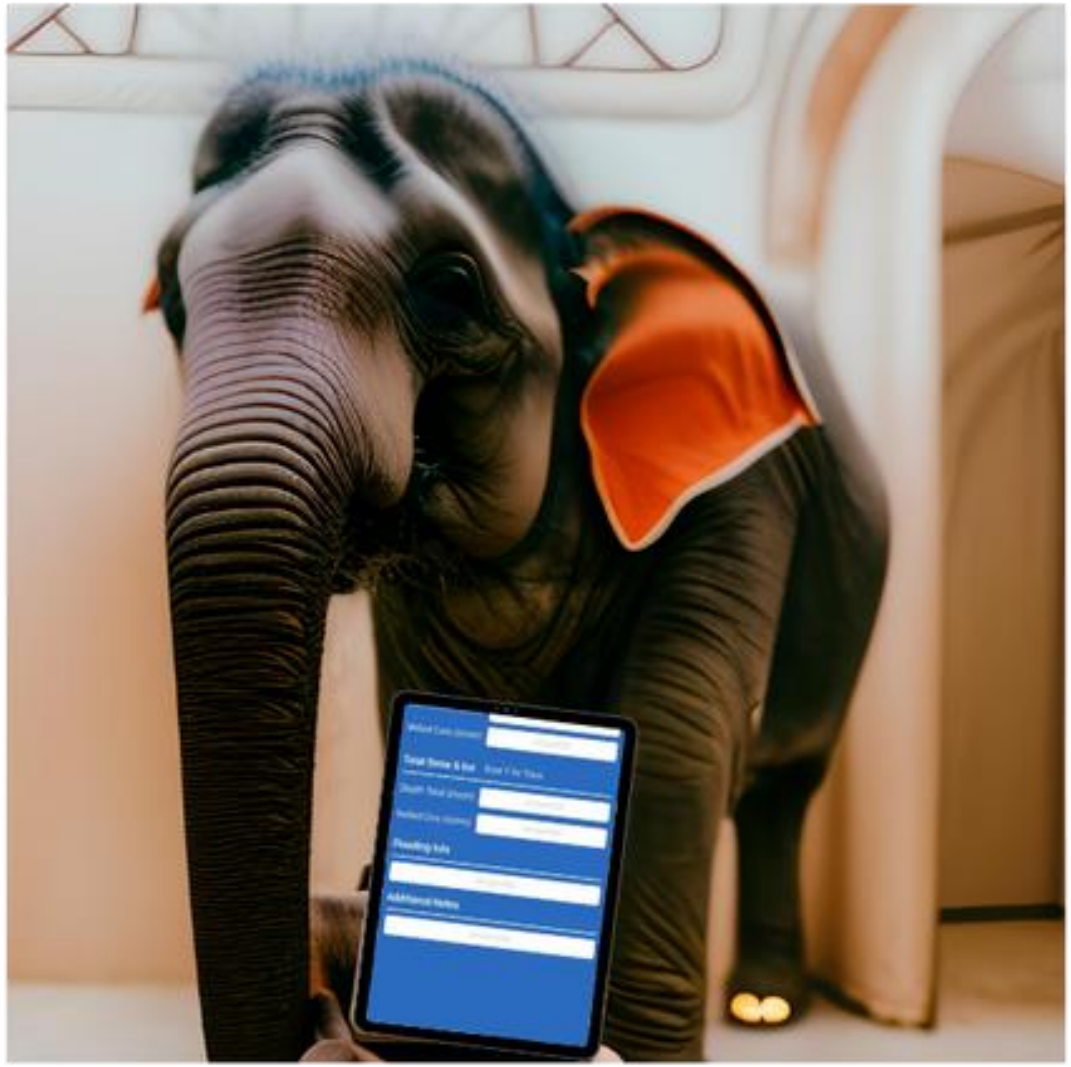


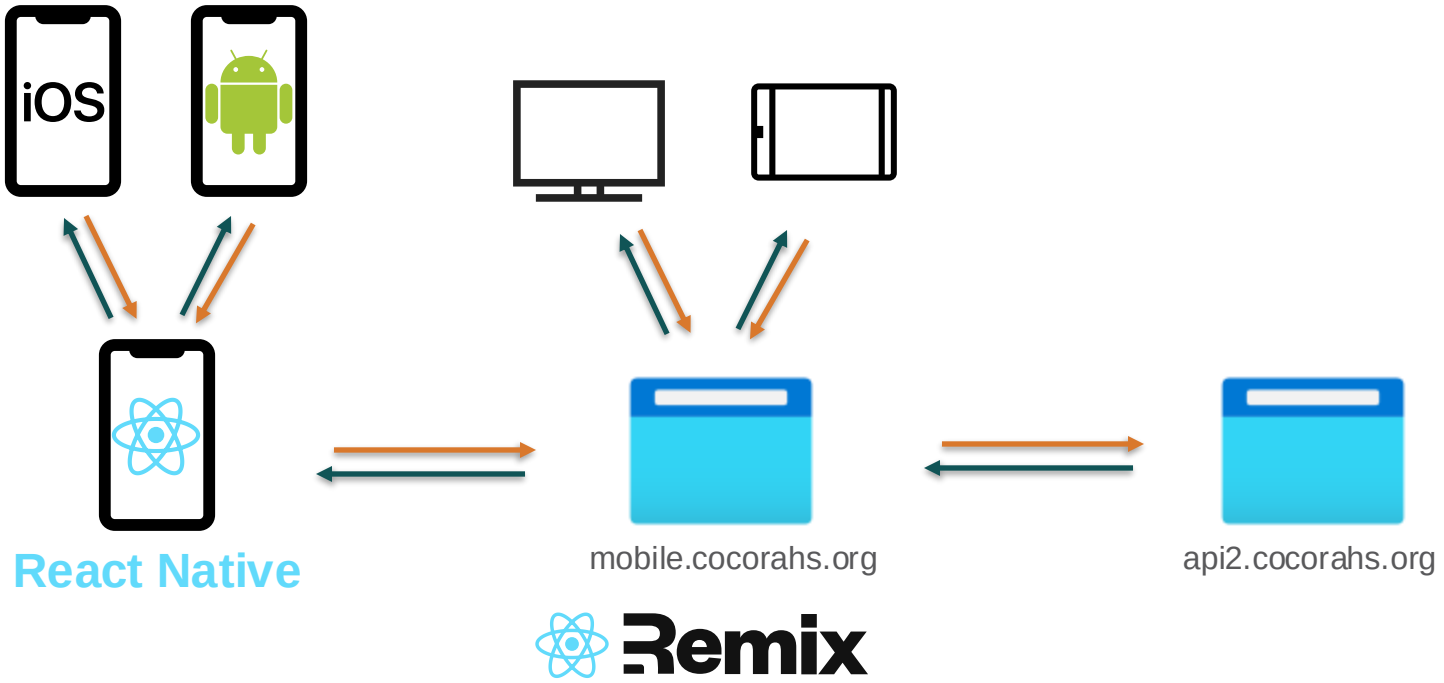
Mobile Apps: The Elephant in the Room

The CoCoRaHS mobile apps were created by an observer years ago. He no longer wants to maintain them

A different approach to mobile applications

Desktop computers, tablets, and phones can use the mobile.cocorahs.org progressive web app (PWA). It will use responsive design techniques to adapt to the device screen size.

A React Native “shell” app will serve as a wrapper for the PWA. Updates to the PWA will be reflected automatically in the mobile apps without a need to push updates to the app stores and wait for users to install them.

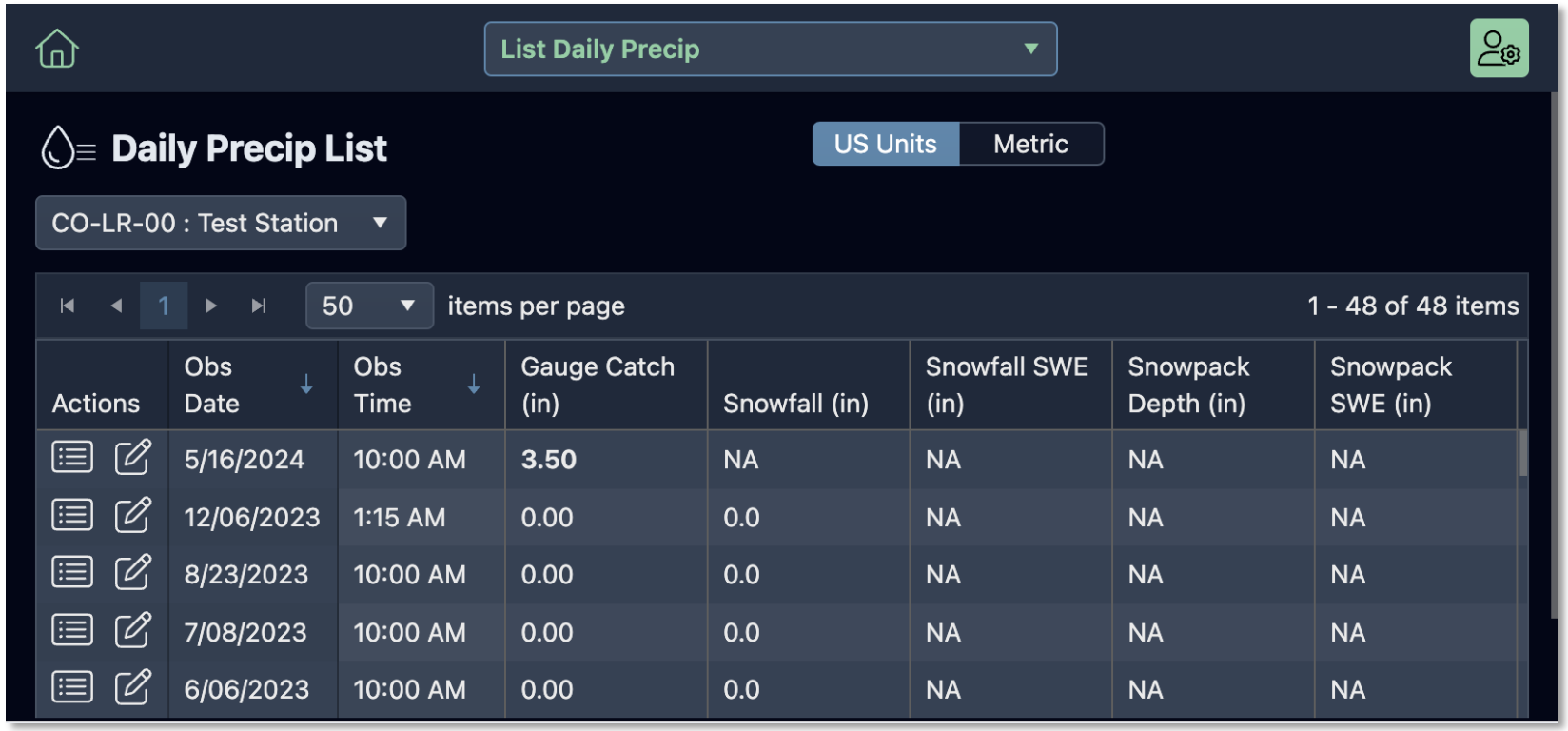


Collaborative Process

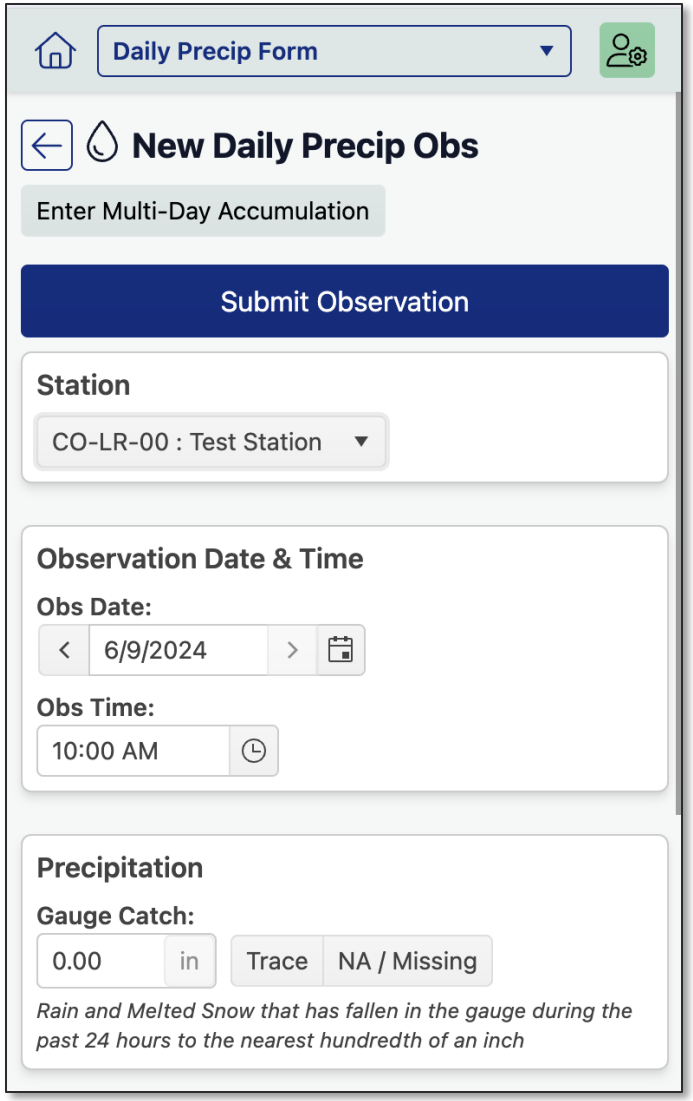
- Over 460 people have submitted at least one observation using the new mobile app
  - Many of them are using it regularly
- Over 160 people have provided feedback via the survey
- Over 110 personal responses have been sent to people who provided feedback
- Many feature additions and layout changes have been based on that user feedback
- Best quote: “I’m old and don’t like change”

CoCoRaHS Mobile App (mobile.cocorahs.org)

Demo



Actions	Obs Date	Obs Time	Gauge Catch (in)	Snowfall (in)	Snowfall SWE (in)	Snowpack Depth (in)	Snowpack SWE (in)
	5/16/2024	10:00 AM	**3.50**	NA	NA	NA	NA
	12/06/2023	1:15 AM	0.00	0.0	NA	NA	NA
	8/23/2023	10:00 AM	0.00	0.0	NA	NA	NA
	7/08/2023	10:00 AM	0.00	0.0	NA	NA	NA
	6/06/2023	10:00 AM	0.00	0.0	NA	NA	NA

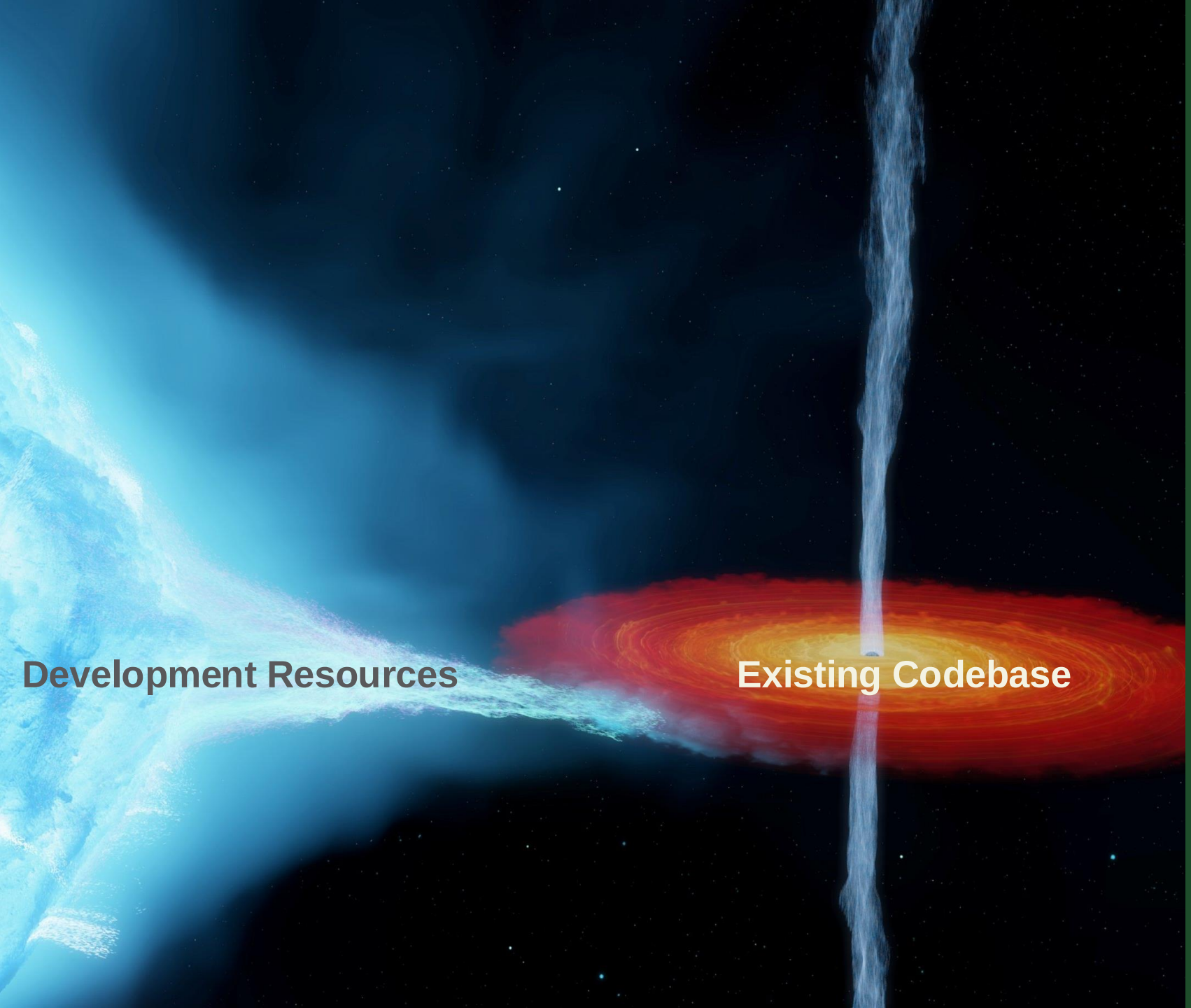


Behind the scenes

- Improve the primary mapping application.
- Improve the primary website.
- Implement an Azure Front Door service with Web Application Firewall across all public facing applications to improve security against dynamic attack vectors, such as bots and hackers whose IP addresses are constantly changing.
- Provided support to CoCoRaHS staff, coordinators, observers, and data users.
- Maintained the CoCoRaHS cyberinfrastructure.
- Upgraded Office 365 email configuration to keep system up to date with security changes.
- Prototyped multiple methods of creating a near real-time data sync between the primary SQL Server database and a PostgreSQL database that will be used for mapping and data analytics.
- Worked on the Colorado Climate Center CoAgMET website

Constraints on IT Dev Capacity

Anything is possible, it’s just a matter of time and money



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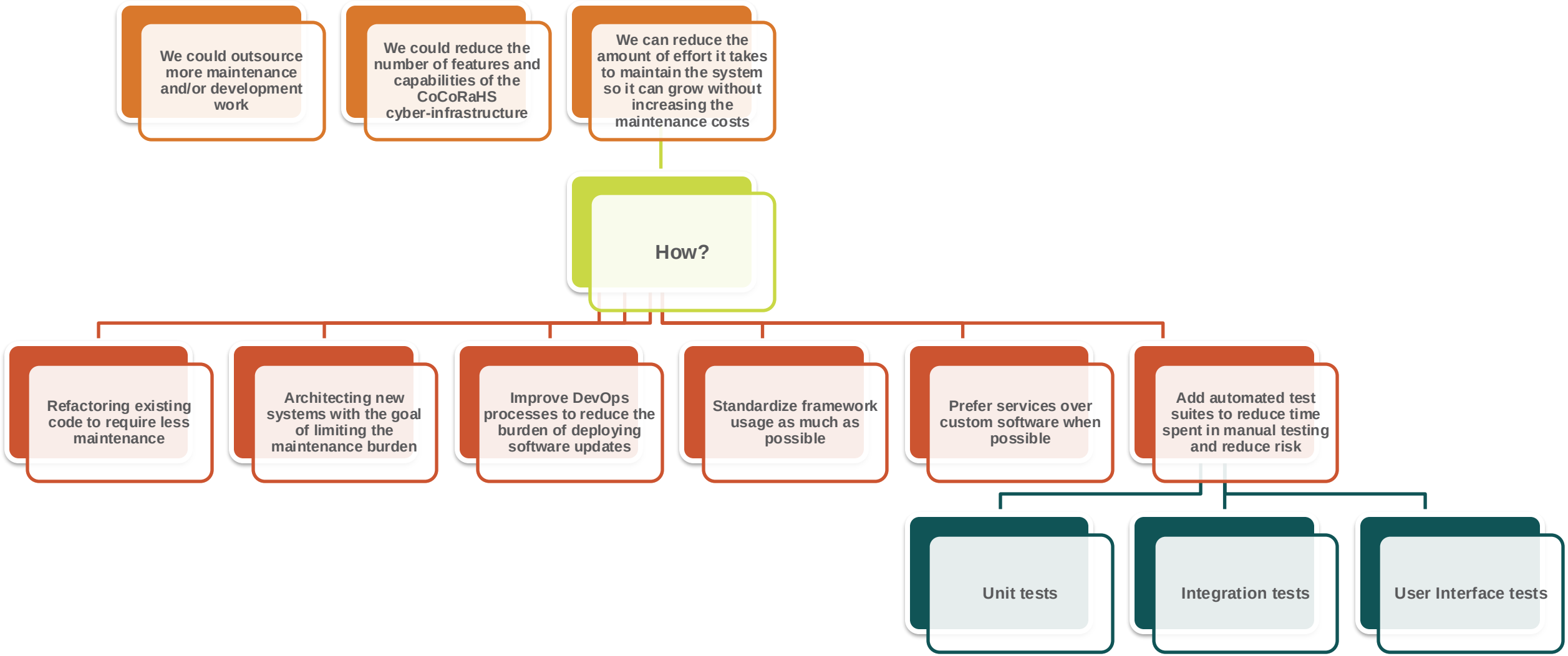
Dichotomy between Software Development and Maintenance

As the software development increases, the amount and complexity of the code-base to be maintained also increases.

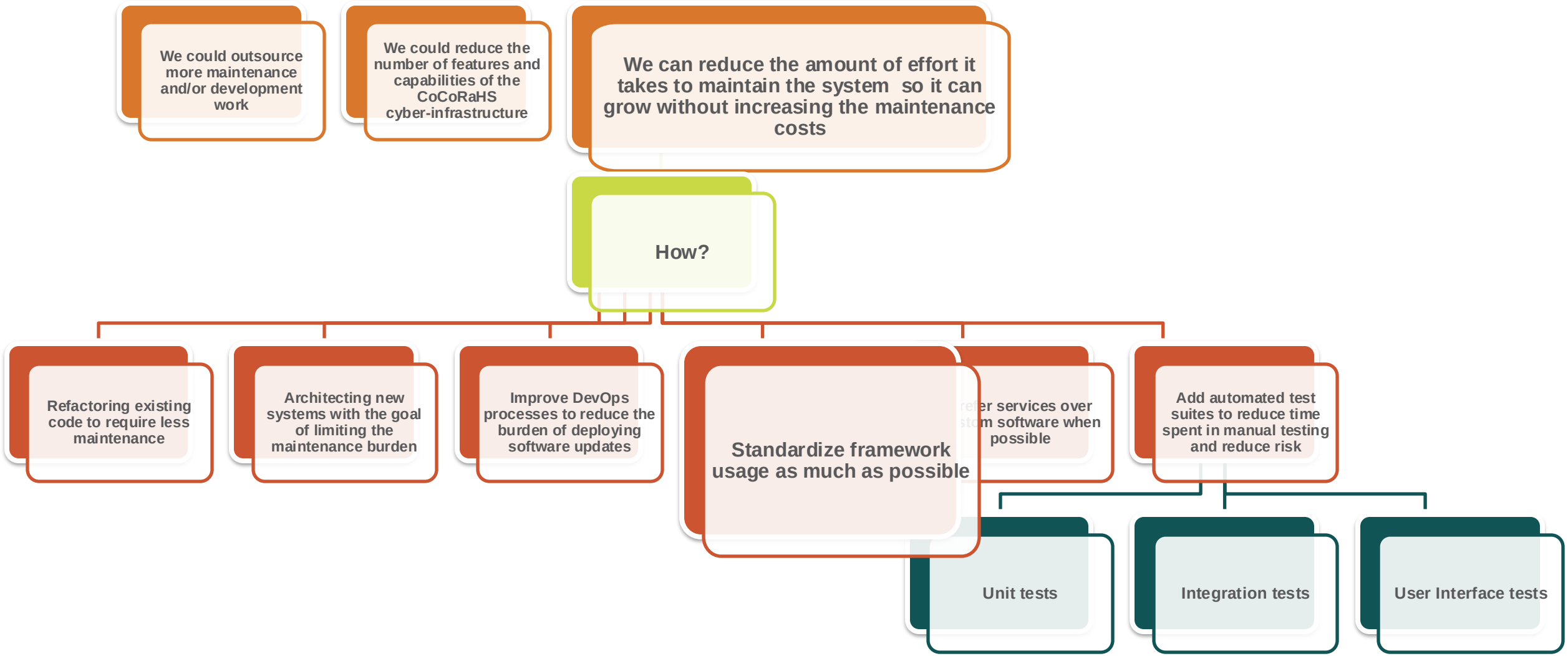
The maintenance load can get so large that all new feature development grinds to a halt.

In a worst-case scenario, the number of features in production decrease as functionality breaks and must be taken offline.

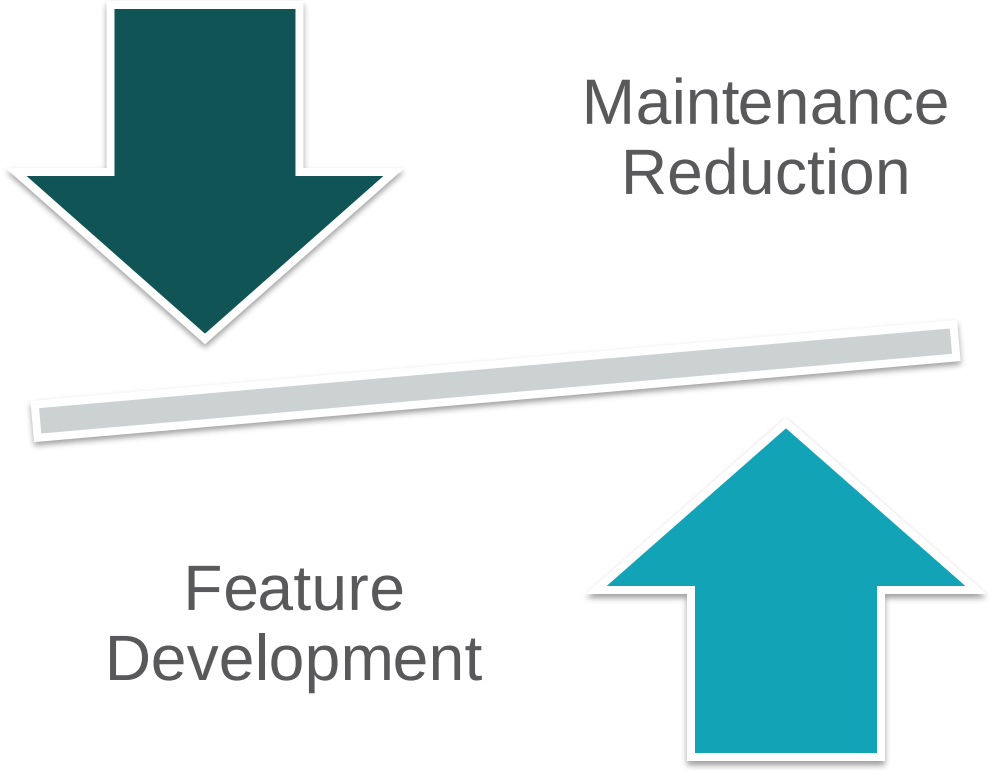
How does CoCoRaHS address this dichotomy?



How does CoCoRaHS address this dichotomy?



Software development to reduce maintenance costs and risk

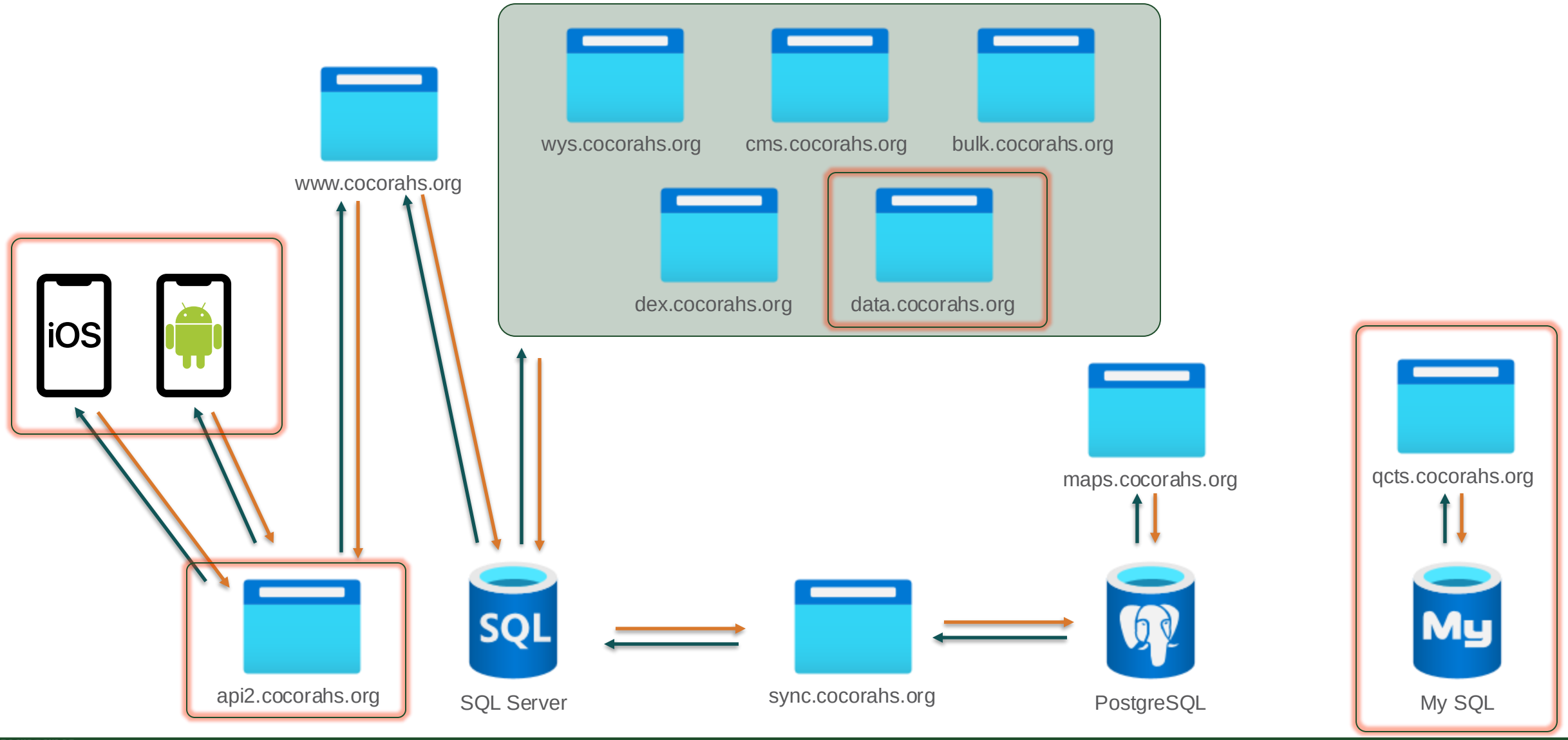


Need to balance maintenance reduction and feature development

Too **much** maintenance reduction =>
no new features **are** being released

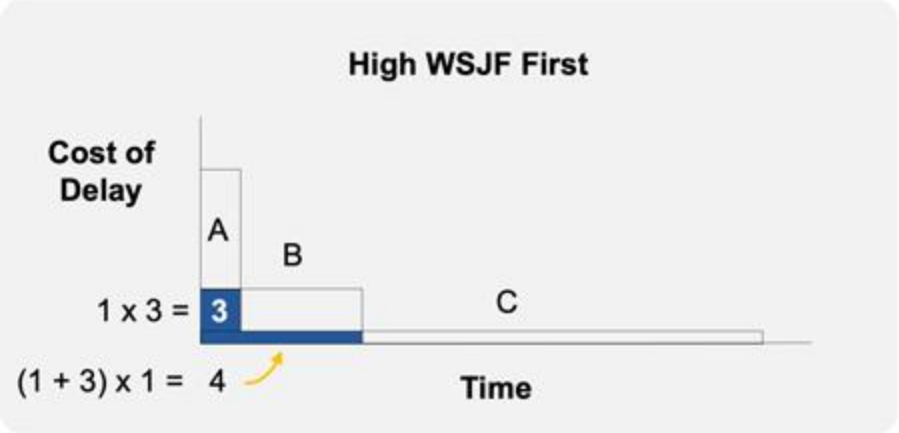
Too **little** maintenance reduction =>
no new features **can** be released

Room for improvement: Places we can consolidate as part of product improvement



Weighted Shortest Job First (WSJF) Process

www.scaledagileframework.com/wsjf/



$$WSJF = \frac{\text{Cost of Delay}}{\text{Job Duration (Job size)}}$$

If effort and CoDs are different, do the Weighted Shortest Job First!

Feature	Duration	Cost of Delay	Weight= CoD/Duration
A	1	10	10
B	3	3	1
C	10	1	0.1

Delay Cost

"Weighted Shortest Job First (WSJF) is a prioritization model used to sequence jobs (eg., Features, Capabilities, and Epics) to produce maximum economic benefit. In SAFe, WSJF is estimated as the Cost of Delay (CoD) divided by job size."

From *The Principles of Product Development Flow*, by Donald G. Reinertsen, Celeritas Publishing,

Overview of the WSJF Process

Estimating the Cost of Delay

Cost of Delay = User-Business Value + Time Criticality + Risk Reduction and/or Opportunity Enablement

Feature	User- business value		Time criticality		RR | OE value	CoD		Job size		WSJF
		+		+	=		÷		=	
		+		+	=		÷		=	
		+		+	=		÷		=	

- Scale for each parameter: 1, 2, 3, 5, 8, 13, 20
- Note: Do one column at a time, start by picking the smallest item and giving it a "1."
- There must be at least one "1" in each column!
- The highest priority is the highest WSJF.

Overview of the WSJF Process

Estimating the Cost of Delay

For user-business value you might ask questions that reflect the goals implied in CoCoRaHS' mission statement:

- How many CoCoRaHS stakeholders might this benefit?
- Will this improve CoCoRaHS data quality?
- Will this improve recruitment and/or retention?
- Will this increase the public's climate literacy?

https://www.productplan.com/glossary/weighted-shortest-job-first/

Overview of the WSJF Process

Estimating the Cost of Delay

For time criticality, we could ask:

- How does the user/business value decay over time?
- Is there a fixed deadline? For instance, a grant funding deadline, or technical deadline like the end-of-life of an Azure service.
- What is the current effect on observer satisfaction?
  - Are observers annoyed at a bug or missing feature?
- Will the stakeholder wait for the feature or look for another solution?

https://www.productplan.com/glossary/weighted-shortest-job-first/

Overview of the WSJF Process

Estimating the Cost of Delay

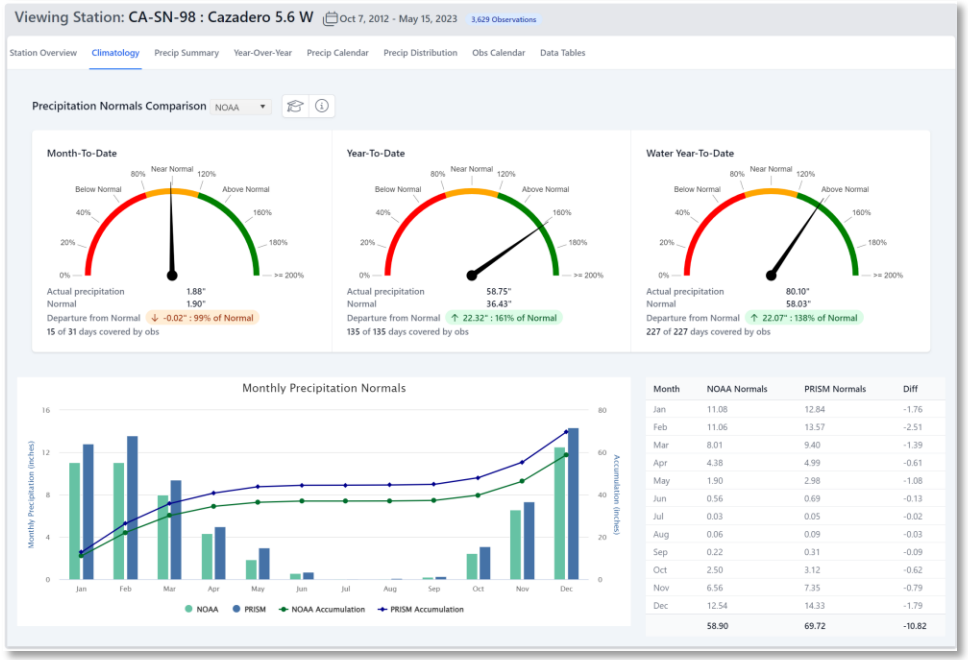
For risk reduction-opportunity enablement, we would ask:

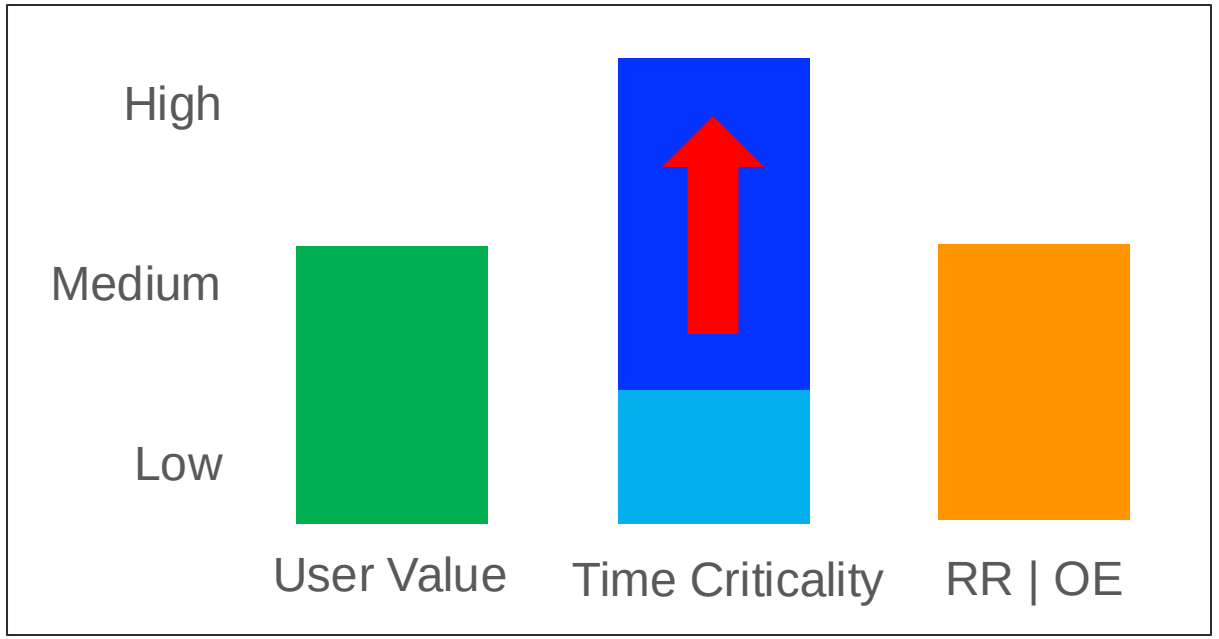
- What else does this do for CoCoRaHS?
- Does it reduce risk? Such as a security risk or operational downtime.
- Is there potential value in the information we will receive? For example, what might the value of adding photo upload to observations be?
- Will this feature enable new business opportunities? For instance, integrating with SciStarter has been a valuable recruitment and retention tool that could not be quantified in advance.

https://www.productplan.com/glossary/weighted-shortest-job-first/

Past WSJF project calculations

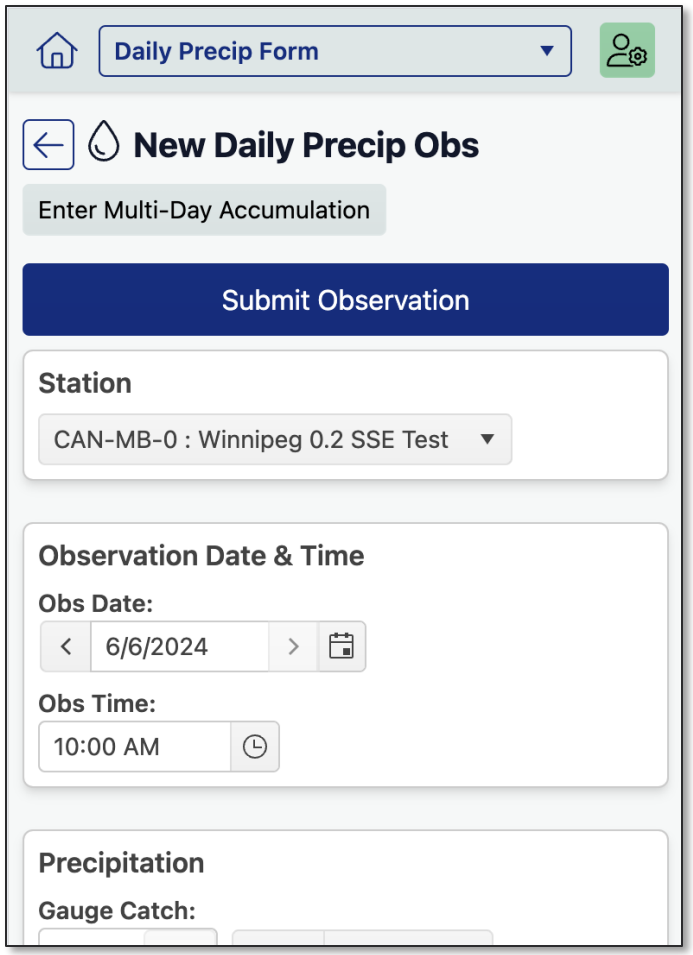
Why DEx?

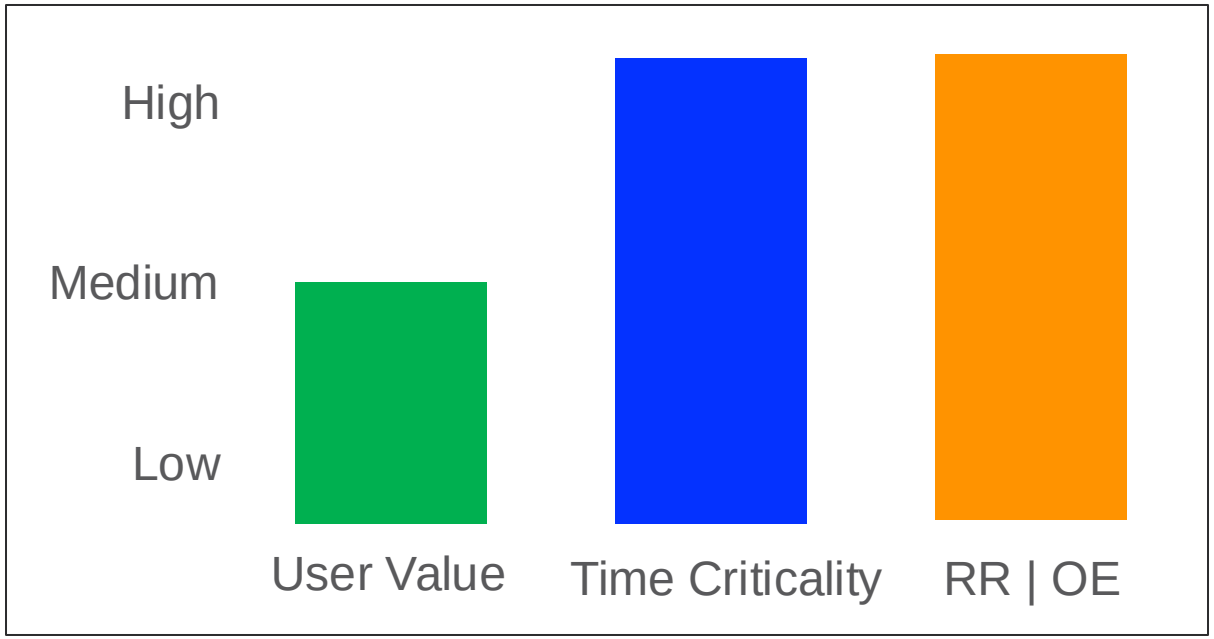




Past WSJF project calculations

Why the mobile app now?



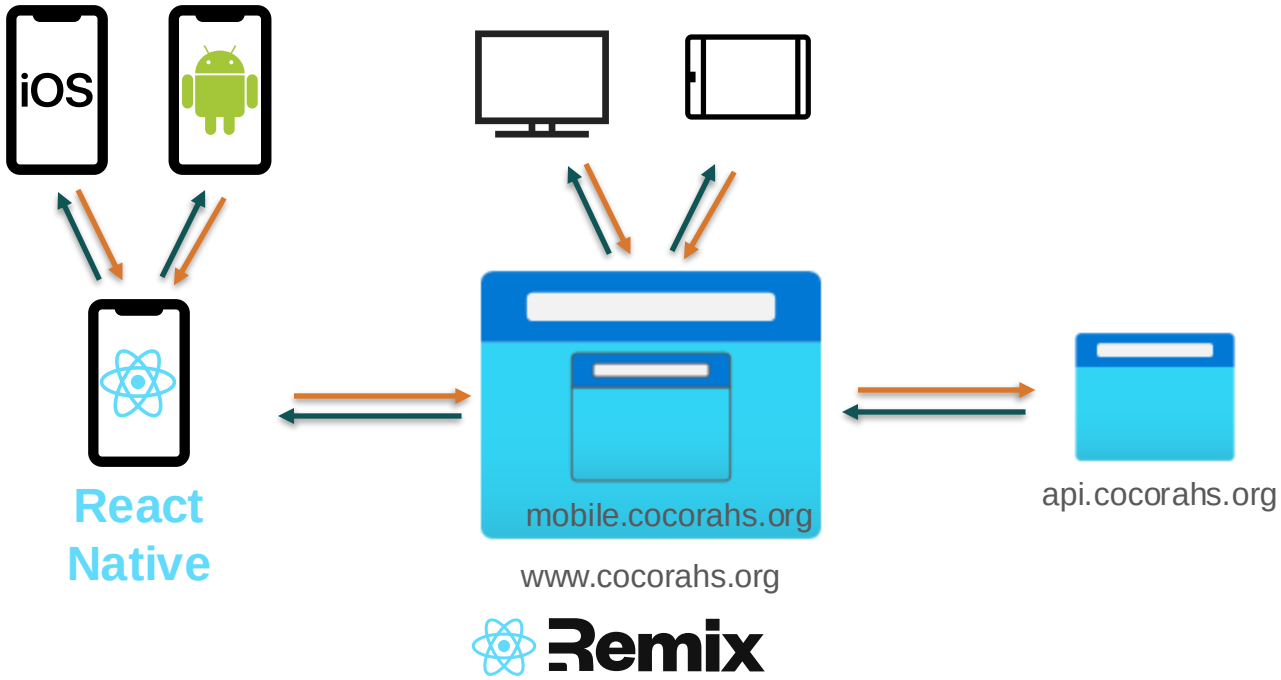


What to do next Potential projects

Mobile App	Mapping	QCTS	Station Metadata	Photo Upload
DEx	CMS	Ice Accretion	Notification System	Metric Improvements
Multilingual	Achievement Dashboard	Mailing List Integration	Coordinator Management	Add unit and integration tests throughout the apps
Add support for OAuth 2 and OpenID Connect	Write grant proposals	Data integration improvements	Review Database Data Versioning	Improve requirements documentation (What)
Data Lakehouse	Improve cyber-infrastructure documentation (How)	Migrate all DevOps to GitHub	Application Monitoring	Cost Management
CoCoRaHS Member Account improvements	Data Integrations with External Networks	ML and Satellite Driven QC	New API and data export	System Admin Documentation

Mobile app expansion and website improvement

What



- Building out the mobile web app until it achieves feature parity with the current website
  - Support all observation types
  - Support all administrative functionality (Managing users, observers, observations, etc.)
  - Support all reports available in the View Data section of the website
- Improve the desktop view of the web app to the point that it is a better user experience than the current website
  - If the mobile web app has all the functionality of the website, and provides a better desktop experience, it can replace the website

Mobile app expansion and website improvement

Why

- We know that 35% of daily precipitation observations submitted this YTD have been via the mobile apps
- The percentage of mobile users has steadily increased over time. In 2022, it was 31%
- Some of those observers don’t use the website and are missing out on a lot of functionality and content they don’t know about
- That functionality and content may be the difference between that observer continuing to be an active participant or moving on
- The website interface needs to be modernized to meet user expectations and facilitate maintenance and extension

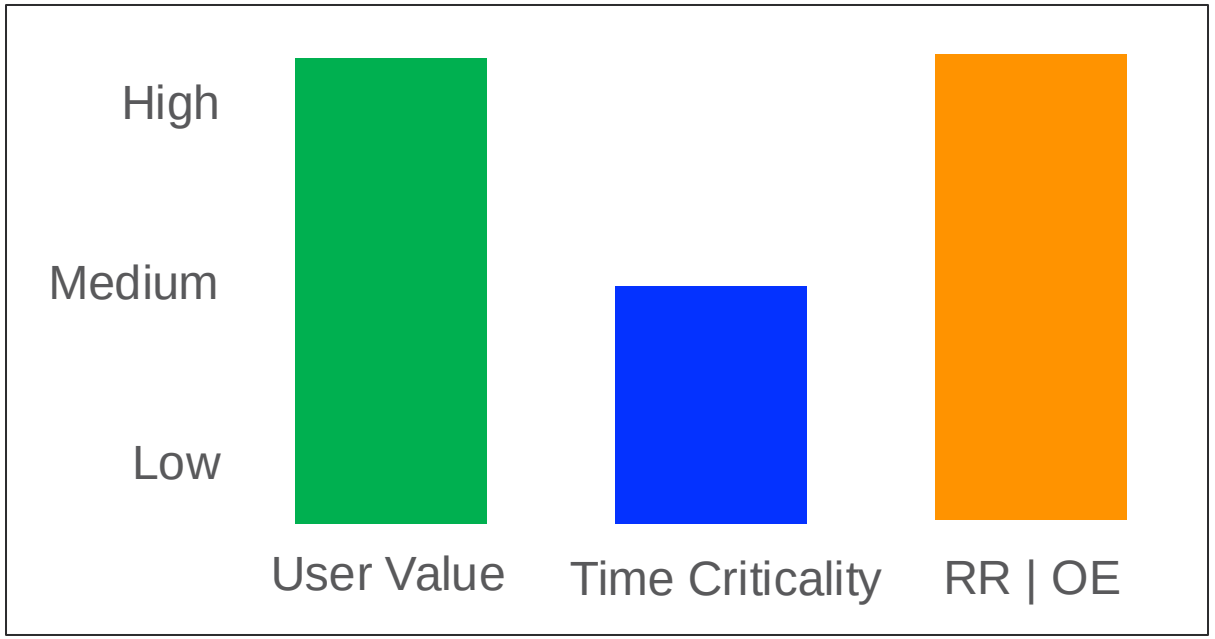
Mobile app expansion and website improvement

WSJF valuations from an IT perspective

UV: Core to the CoCoRaHS mission

TC: Pressing, but not urgent

RR | OE: Older web framework has inherent risks and limitations



Develop a new CoCoRaHS API and replace data.cocorahs.org

What

- Consolidate the existing API web application and the data.cocorahs.org export web application into a single new Web API
- Provide all the reports available under the ‘View Data’ section of the website as API endpoints
  - This would make reports available in JSON, CSV, XML for the mobile app as well as data users
- Create an API key management system so that we can track individual data users
  - This will enable publicizing the API and integrating it into web applications because we won’t be exposed to Denial-of-Service attacks
- Major functional groups
  - Data Export
  - View Data Reports
  - Observer Functionality (What’s in the current API)
  - Admin: Observation, Observer, Station, User Group, and Permission Management

Develop a new CoCoRaHS API and replace data.cocorahs.org

Why

- The current data export is having a harder time keeping up with the export demands of data users
  - Using data streams for responses with hundreds of thousands of records would be more efficient and less likely to timeout
- Data users and observers have regularly requested raw data versions of our summary reports
- A single API could act as a universal data access layer, providing a single point of contact to the database across web applications
  - This would make easier to make changes to the underlying database schema to make long needed improvements
- The mobile app expansion project depends on functionality provided by this project

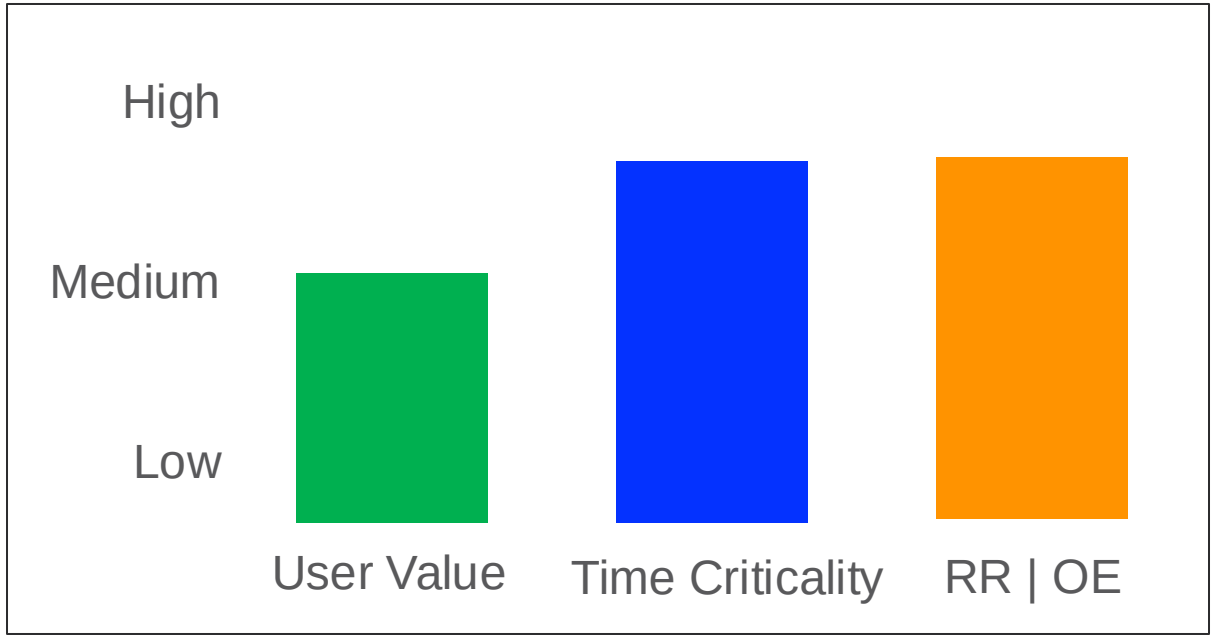
Develop a new CoCoRaHS API and replace data.cocorahs.org

WSJF valuations from an IT perspective

UV: The functionality a new API could provide would be especially valuable to data users. It could also make it easier for observers to get data in formats they can work with, which would expand the pool of data users.

TC: I would rate the time criticality of the API project is higher since the mobile app expansion depends on it.

RR | OE: An improved API, especially one with the token management to prevent against abuse, would create opportunities to build educational products for budding data analysts to learn climate literacy and data literacy at the same time.



DEx expansion

What

The Data Explorer has been a popular addition to CoCoRaHS. With that has come many great suggestions for improvement. Currently DEx is focused on highlighting data for a single station.

Possible improvements include:

- Data comparison between stations
- Station and regional data analysis
- Provide charts for condition monitoring analysis
- Improve logging
- Improve data caching and service resiliency
- DEx could eventually cover all summary reports included in ‘View Data’ section of website

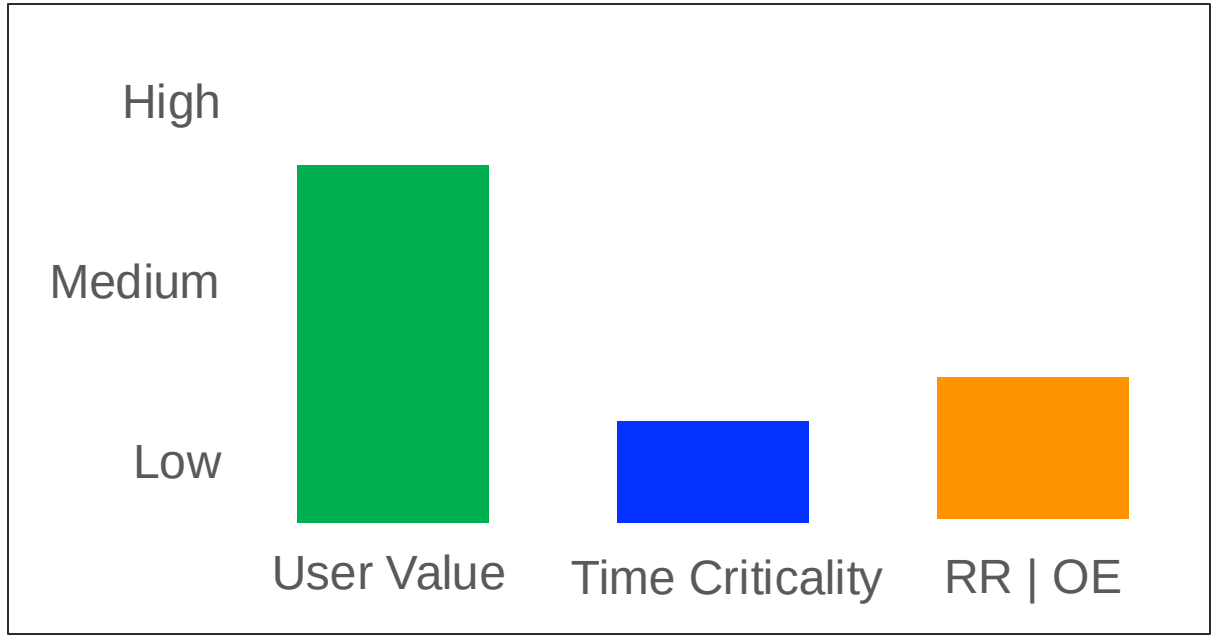
DEx expansion

Why

- People like DEx and would welcome more functionality
- Additional data analysis features provide more climate literacy education opportunities
- The application could be made more reliable
- Providing reports available in ‘View Data’ facilitates the website modernization project
- The platform would make it easier to provide new data visualizations

DEx expansion

WSJF valuations from an IT perspective



UV: Given the positive feedback for the first version of DEx, it is likely that improvements and additional functionality would be welcomed by most stakeholders.

TC: Without specific funding for DEx, there is not much urgency for this project to move forward compared to other projects.

RR | OE: There is not much risk associated with leaving DEx as it is for the time being. Enhancing it should lead to opportunities for climate education products and improve observer retention.

Mapping

What

- Rebuild our current Angular maps.cocorahs.org web application to migrate from the Carto raster mapping platform to their new vector mapping platform
- The new application would be built with Remix React to align with DEx and the mobile web application
- The PostgreSQL database would go from a shared Carto database to one that CoCoRaHS manages in Azure
- The new platform will enable functionality beyond what the current platform can offer
  - Zooming and panning is faster
  - Users will be able to have the dynamic key adjust to the data in the map viewport instead of the entire map dataset
    - This is an often-requested feature for state and local map analysis
- This could include:
  - Incorporating the Condition Monitoring maps into the primary mapping application
  - Recreating the watershed mapping functionality that we had to turn off for budget reasons

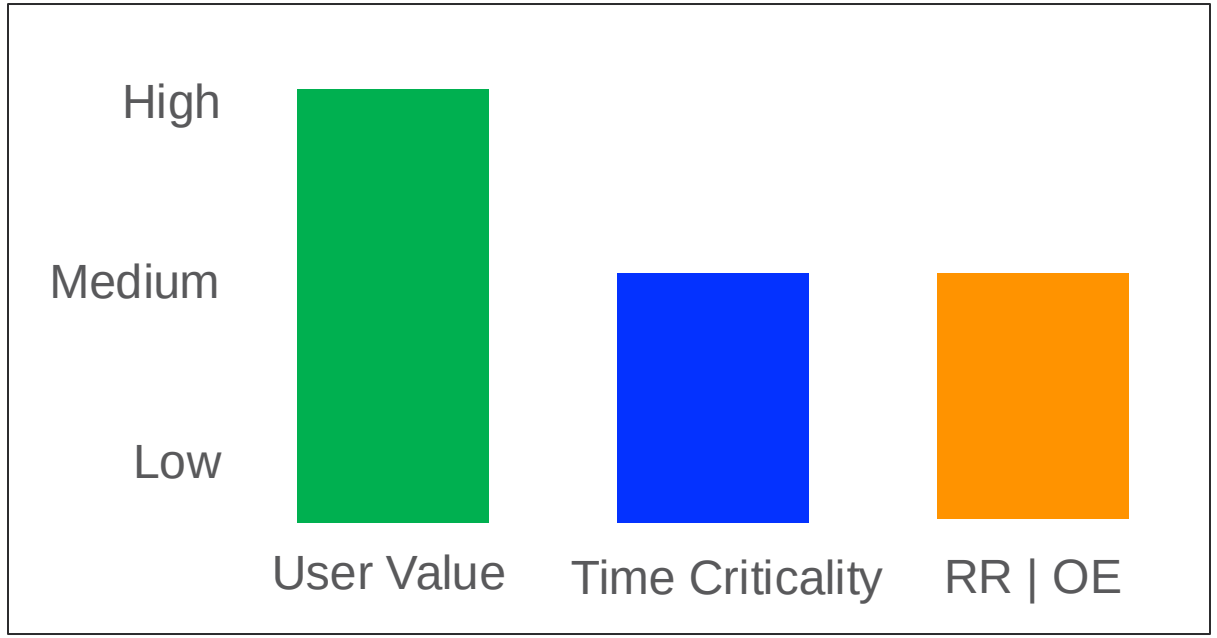
Mapping

Why

- We know the maps are a valuable tool regularly used by observers, the public, data users, and staff. So, improvements to our mapping capabilities have the potential to have a large impact
- There are requested features that the current raster-based mapping system can’t support
- As the mapping dataset and number of users grow, the current mapping system sometimes has performance issues during peak usage
- Carto is willing to provide additional development support

Mapping

WSJF valuations



- **UV**: Maps are a big part of what CoCoRaHS does and one of the highest value products we provide to observers and data users. Improvements made to the mapping system affect many stakeholders.
- **TC**: Carto's help in migrating to the new platform has some urgency to it as they are looking to use CoCoRaHS as a testbed for improvements to their documentation and as an example for other customers looking to migrate.
- **RR | OE**: The primary much risk in keeping with the current mapping system would be performance issues during peak usage. There is a high potential upside if we can build a better mapping system and have the project promoted by Carto.

Photo Upload

What

Photo upload image processing and storage

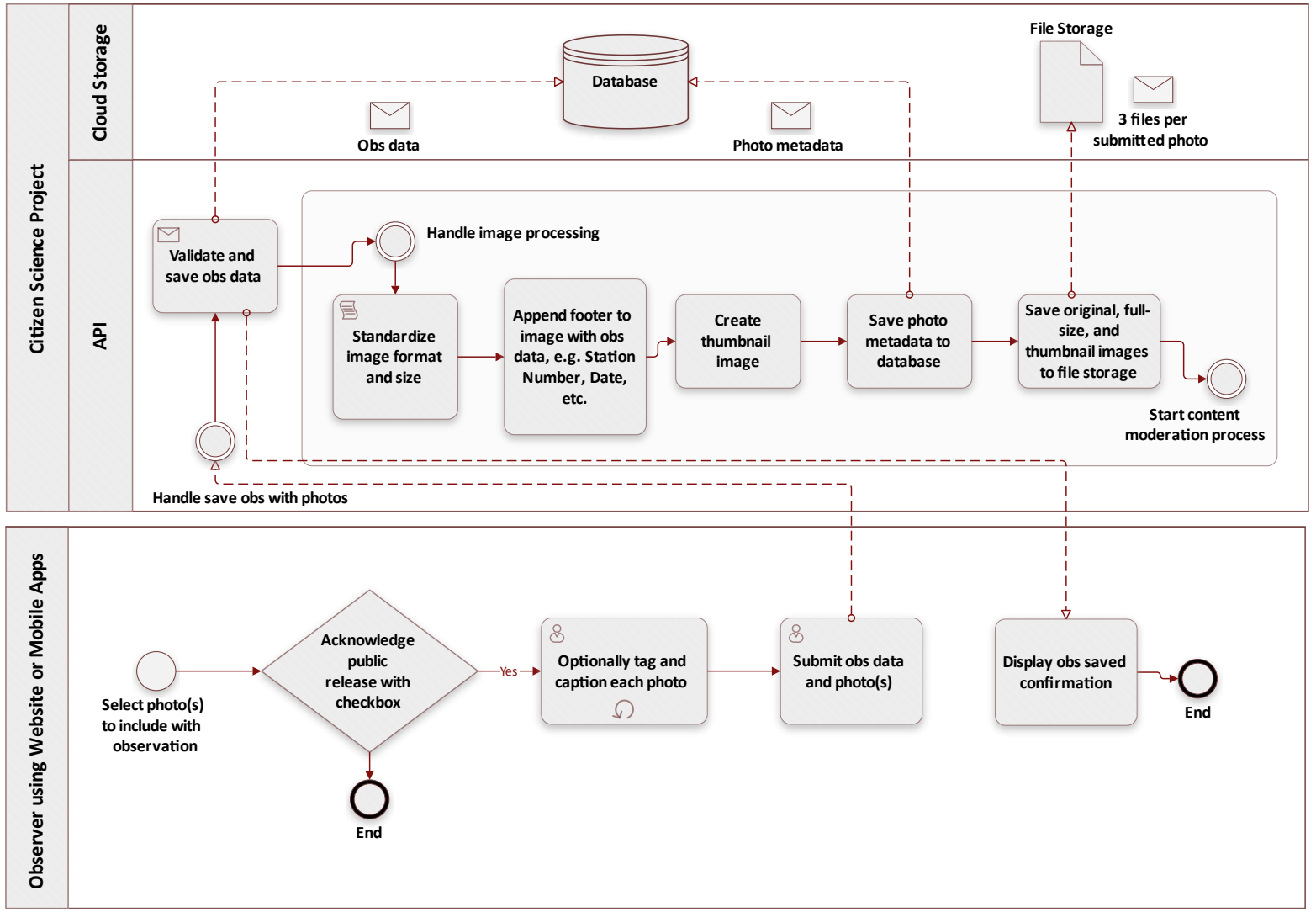


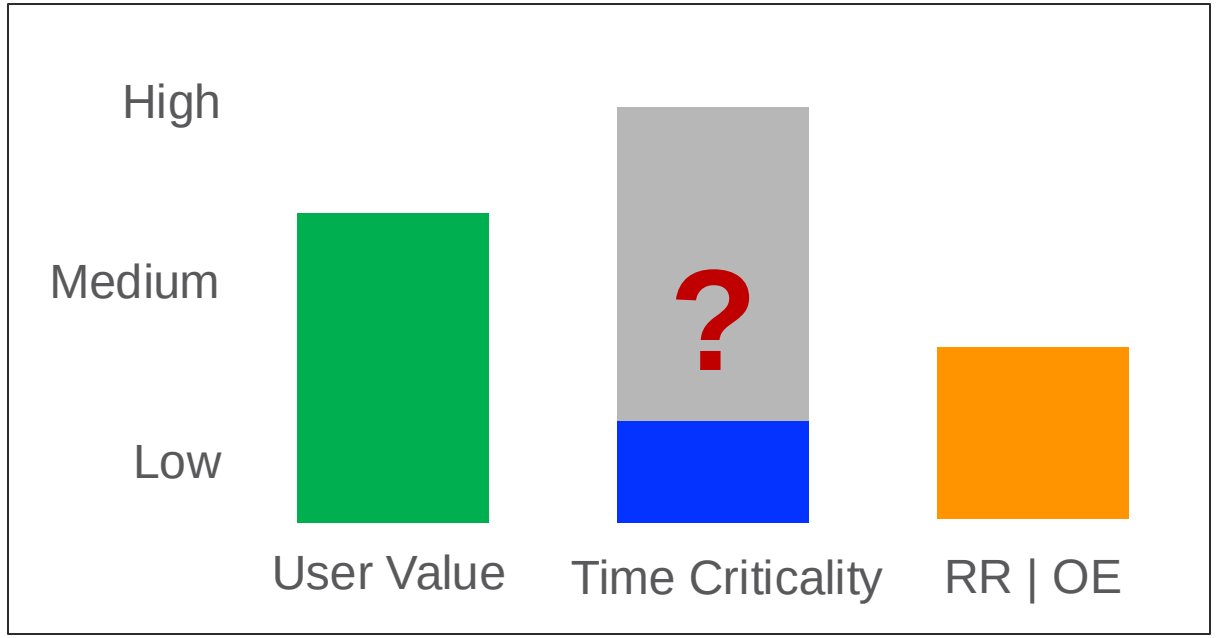
Photo Upload

Why

- Photos could provide valuable context to observations, especially hail and condition monitoring
- Photos would be a required component if we add ice accretion in the future
- Observers would probably like photos to be optional for all observations types so they can share things like snow photos
- Photos may be a good recruitment tool if observers share links to their CoCoRaHS photos on social media
- Photos could be a beneficial QC tool
- Photos could prove valuable for analysts using computer imaging in their machine learning models

Photo Upload

WSJF valuations



- **UV**: Photo upload has the potential to add significant value for data users as well as observers.
- **TC**: It has been included in several grant proposals, giving it a higher likelihood of receiving direct funding, which would boost it's time criticality similar to DEx.
- **RR | OE**: Supporting photo upload is more likely to bring risks that alleviate risks. However, it would bring opportunities to improve QC in the near-term and potentially valuable for analysists using computer imaging in their ML models.

QC Ticketing System

What

Background: The current QCTS was inherited years ago. It runs in Azure like the rest of the CoCoRaHS cyberinfrastructure, but it is completely isolated from it. It uses a separate database (MySQL), a separate web application scripting language (JSP), and a separate deployment model (Docker).

- Complete rewrite of the QCTS to use the primary SQL Server database and the same server-side and client-side frameworks the rest of the CoCoRaHS applications are built with
- To start using the existing QCTS app as the Minimum Viable Product (MVP)
- Then adding features to improve the integration between the QCTS and other CoCoRaHS apps
- The most complicated aspect is the routing of notification emails to the correct coordinators

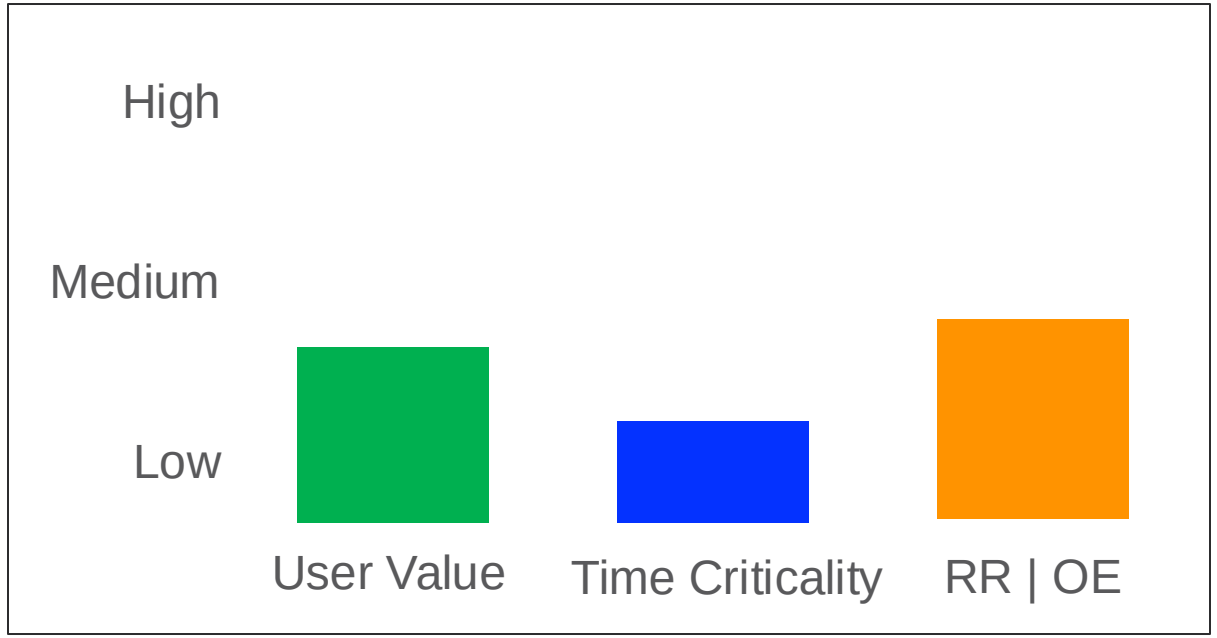
QC Ticketing System

Why

- QC is a mostly invisible but important part of daily operations
- It adds value to the dataset, unfortunately, it's hard to quantify that value
- The current system is fragile
- The current system has performance issues
- The current system cannot be improved upon, we need to take a step back and replace it if we want to move forward
- Moving the data from the separate MySQL database to the primary SQL Server database will save on monthly operating expenses
- It would be easier to convince coordinators to use the QCTS if it had a better user experience

QC Ticketing System

WSJF valuations



- **UV**: The QCTS is an important part of daily operations but invisible to observers.
- **TC**: This project is not likely to get funded.
- **RR | OE**: The current system is lacking. A new QCTS would create many opportunities for improved integration. It would also encourage more coordinators to participate in QC.

Station Metadata

What

- Create forms and displays for storing and tracking station metadata similar to COOP
- Photos of the gauge to verify that it is installed properly and is not obstructed
- Potentially store gauge type as well
- Include station affiliation as an attribute
  - e.g. House/Residence, School, Farm, Master Gardeners, Master Naturalists, Library, Museum, etc.
- Include the ability to version station metadata over time

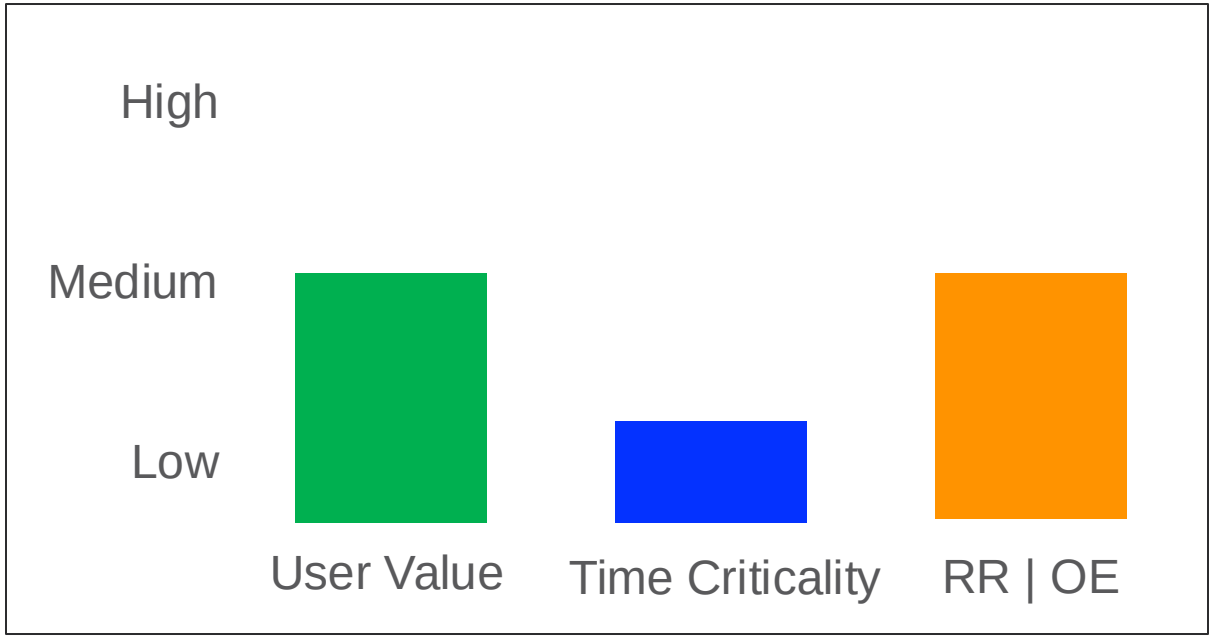
Station Metadata

Why

- Station metadata photos will help up catch gauge installation issues sooner
  - We may also find out if some observers are using automated gauges, wedge gauges, etc.
- Other attributes such as site descriptions could prove valuable in the future
- Attributes such as station affiliation could be useful in data analysis

Station Metadata

WSJF valuations

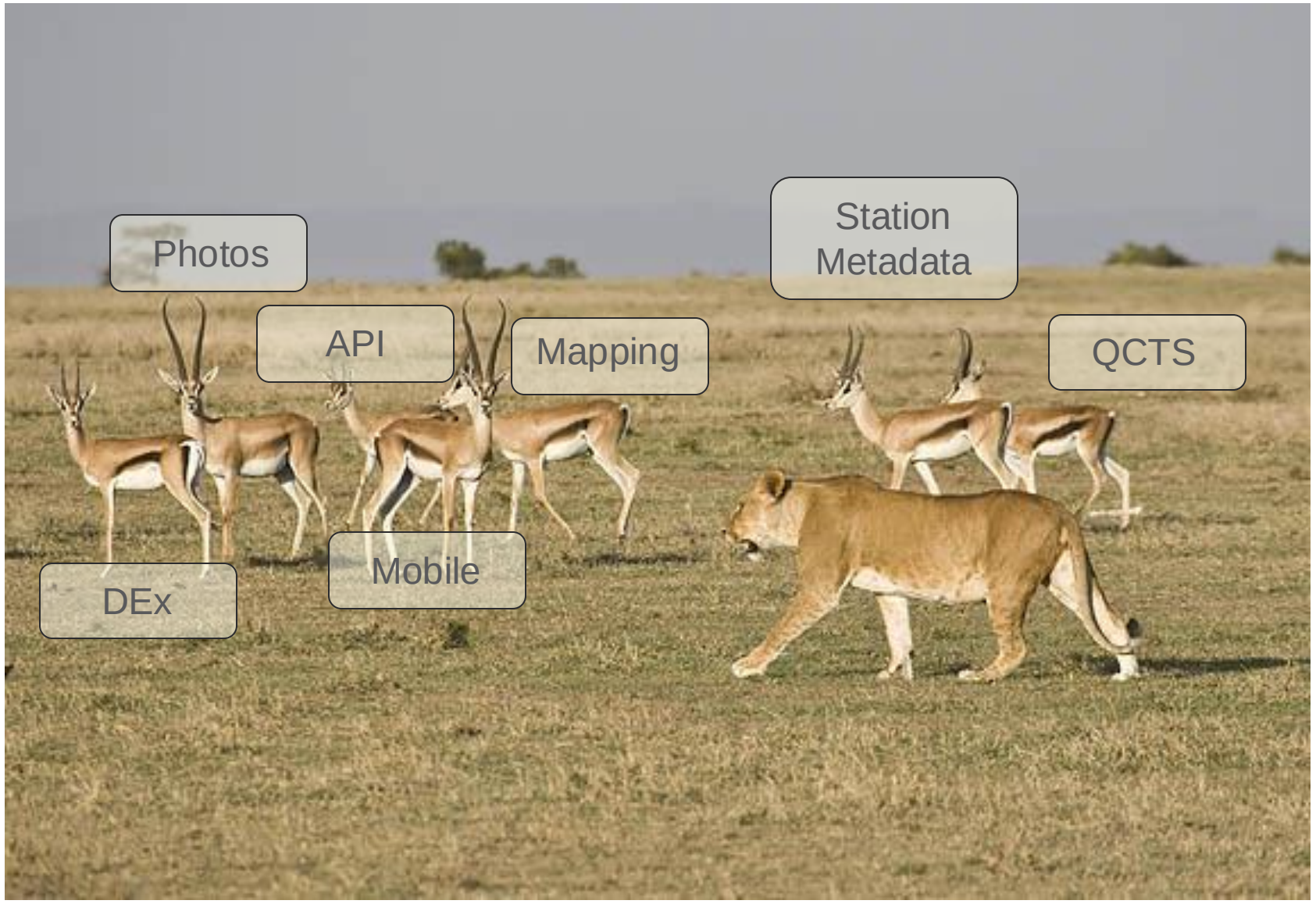


- **UV**: Would be of higher value to data users than observers
- **TC**: Low likelihood of being funded
- **RR | OE**: Would create opportunities to improve data quality

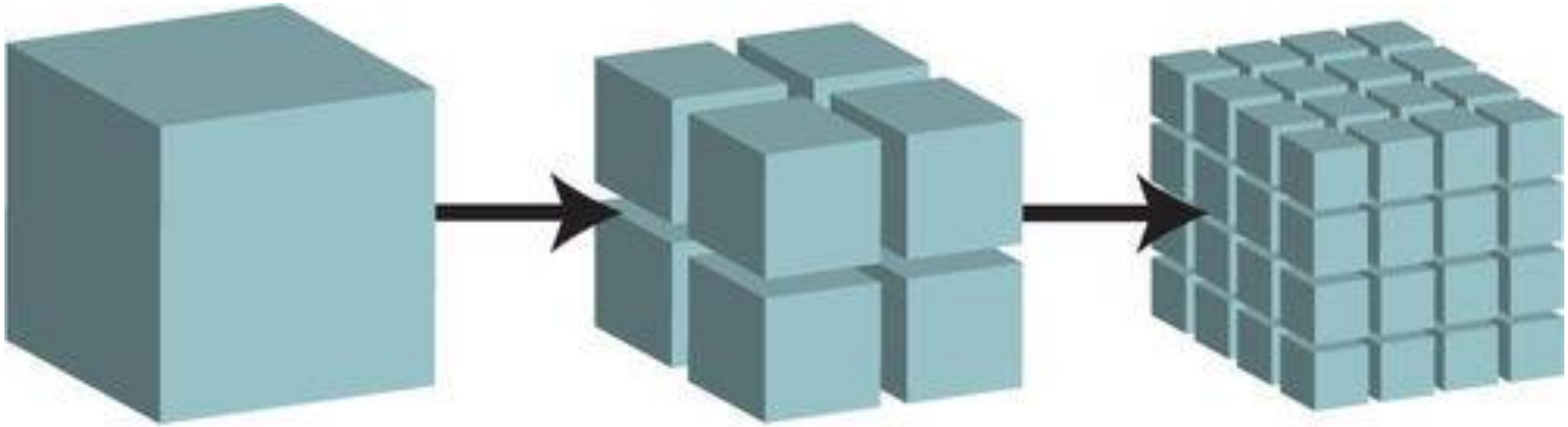
What about job size?

$$\text{WSJF} = \frac{\text{Cost of Delay}}{\text{Job Duration (Job size)}}$$

How to work on more projects at a time

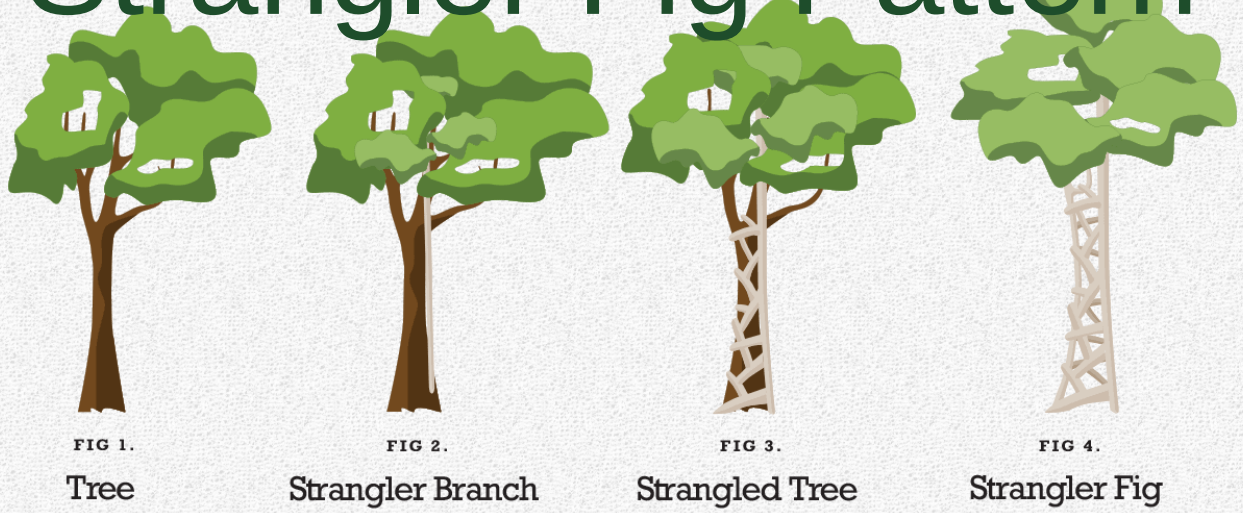


How to work on more projects at a time

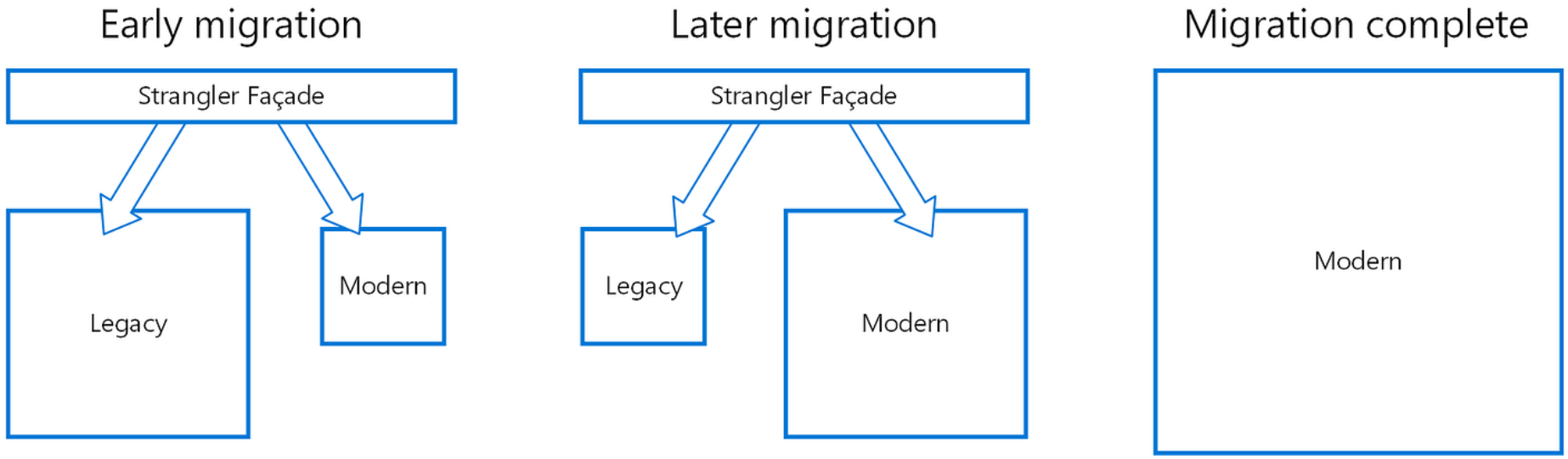


- **Break projects down into smaller features**
- **Apply WSJF at the feature level**
- **Manage scope creep**

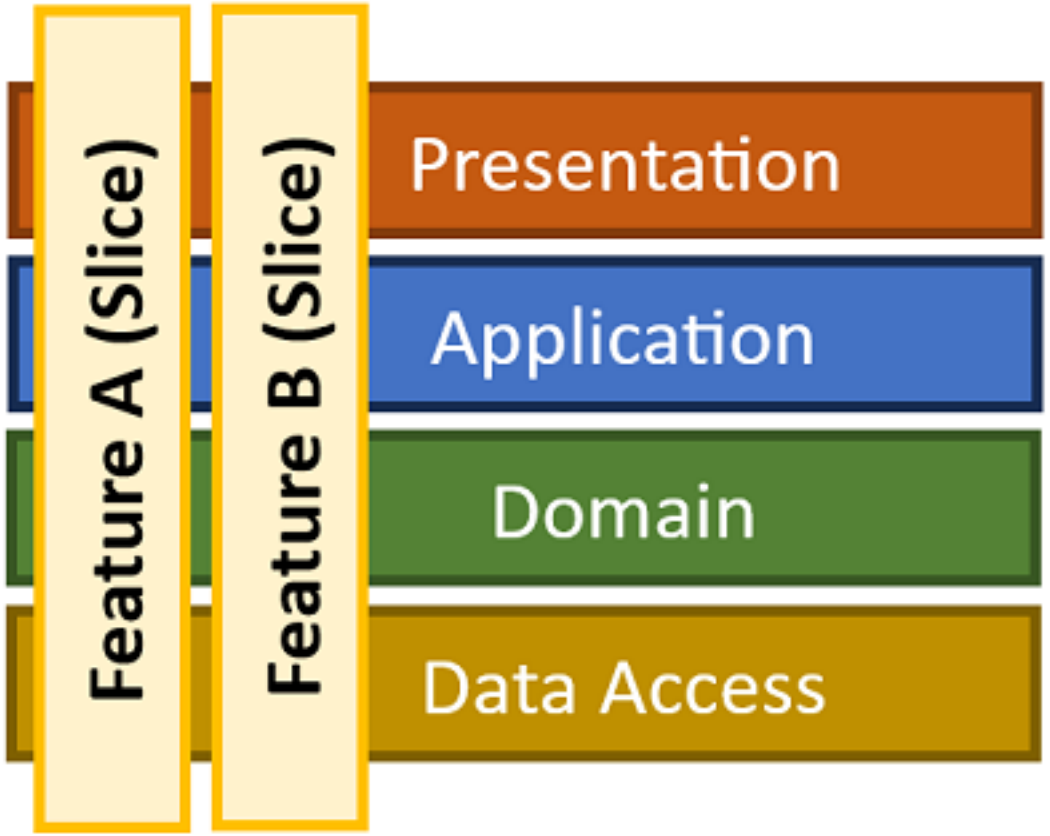
Strangler Fig Pattern



"The Strangler Fig pattern aims to incrementally re-write small parts of your codebase, until after a few months/years, you have strangled all your old codebase and it can be totally removed."



Vertical slice architecture



"Vertical Slice Architecture… emphasizes the grouping of code associated with similar functionality, ideally within a single class, file, or package. This approach resonates with human preference for neatly packaging-related elements in one cohesive unit."

In some cases, we can adapt this concept for functional units that cross projects. For example, the 'View Data' reports slice would cover the mobile app, DEx, data export, and API projects.

Tell us what you value

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Thank you

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