

# In Your Orbit

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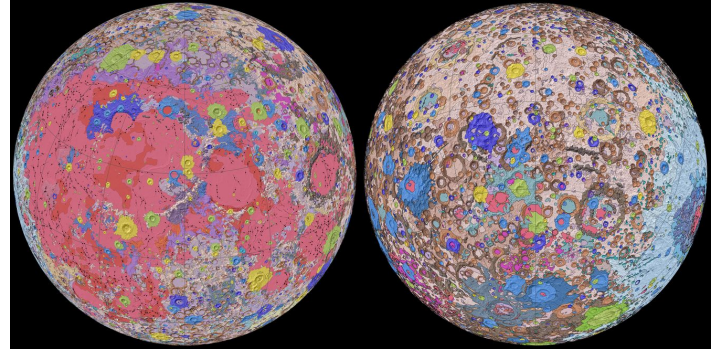
# Introduction

- Rapid growth in planetary science and NASA missions
- Importance of sensor models in mapping planetary surfaces
- Challenges of accessing NASA's vast SPICE database
- **Capstone Project:** cloud-based service for ISD retrieval
- **GOAL:** Improve accessibility for new planetary scientists



# Problem Statement

- Image Support Data (ISD) crucial for planetary missions
- USGS Astrogeology generates ISDs from satellite images
- Current system issues (complex, expensive, data size, inefficient)
- New system will be faster, free, and user friendly



# Solution Overview



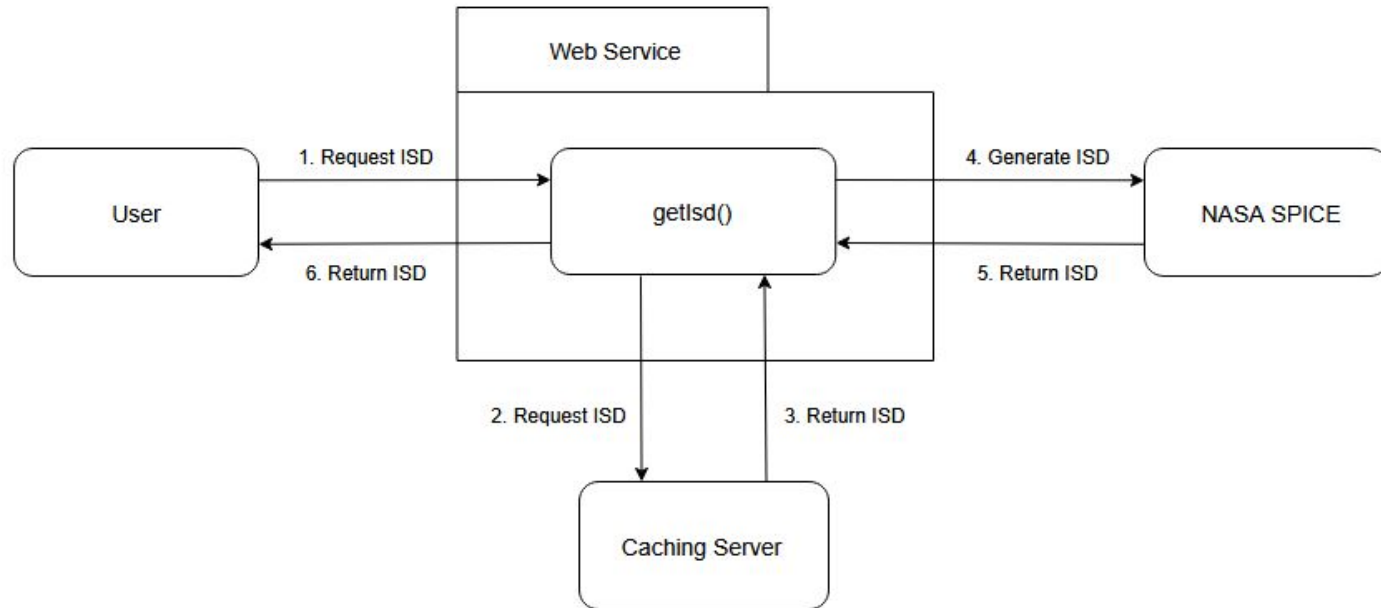
- **ISD Generation:** The web service generates ISD using ALE, a NASA tool for ephemeris data.
- **Caching for Speed:** Stores frequently requested ISDs on Amazon DynamoDB for fast retrieval.
- **AWS Integration:** Uses Amazon ECS for scalability, enabling the service to handle large volumes of requests.
- **Data Efficiency:** Compressed JSON format reduces data size, speeding up data transfer and minimizing storage needs.

# Key Requirements

- Queryable system for retrieving ISDs
- Web Service that acts as interface between user and ISD retrieval
- Caching server that stores ISDs

# Implementation Overview

Web Service:



# Prototype Review

AWSTemplateFormatVersion: 2010-09-09

Description: DynamoDB Deploy

Resources:

DynamoDB:

Type: AWS::DynamoDB::Table

Properties:

AttributeDefinitions:

- AttributeName: "id"
- AttributeType: "S"

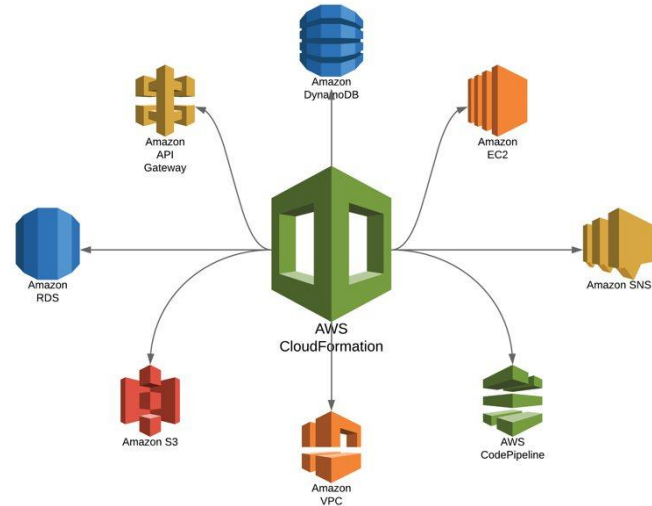
KeySchema:

- AttributeName: "id"
- KeyType: "HASH"

ProvisionedThroughput:

ReadCapacityUnits: 15

WriteCapacityUnits: 15



# Prototype Review

```
austin@Austin: ~/ale/websern x + v
(isis) austin@Austin:~/ale/webservice/Cloud-Based-Planetary-Ephemerides/API$ uvicorn isdAPI:app --reload
```

```
austin@Austin: ~/ale/websern x + v - □ x
(isis) austin@Austin:~/ale/webservice/Cloud-Based-Planetary-Ephemerides/API$ uvicorn isdAPI:app --reload
INFO: Will watch for changes in these directories: ['/home/austin/ale/webservice/Cloud-Based-Planetary-Ephemerides/API']
INFO: Uvicorn running on http://127.0.0.1:8000 (Press CTRL+C to quit)
INFO: Started reloader process [2117] using StatReload
INFO: Started server process [2119]
INFO: Waiting for application startup.
INFO: Application startup complete.
```



# Prototype Review

```
austin@Austin: ~/ale/websevi x austin@Austin: ~/ale/websevi x + v
(isis) austin@Austin:~/ale/websevi/Cloud-Based-Planetary-Ephemerides/API$ python api_tester.py
```

```
austin@Austin: ~/ale/websevi x austin@Austin: ~/ale/websevi x + v
(isis) austin@Austin:~/ale/websevi/Cloud-Based-Planetary-Ephemerides/API/test_data$ ls
f004a47_isis3_0.lbl f004a47_isis3_27.lbl f004a47_isis3_45.lbl f004a47_isis3_63.lbl f004a47_isis3_81.lbl
f004a47_isis3_1.lbl f004a47_isis3_28.lbl f004a47_isis3_46.lbl f004a47_isis3_64.lbl f004a47_isis3_82.lbl
f004a47_isis3_10.lbl f004a47_isis3_29.lbl f004a47_isis3_47.lbl f004a47_isis3_65.lbl f004a47_isis3_83.lbl
f004a47_isis3_11.lbl f004a47_isis3_30.lbl f004a47_isis3_48.lbl f004a47_isis3_66.lbl f004a47_isis3_84.lbl
f004a47_isis3_12.lbl f004a47_isis3_31.lbl f004a47_isis3_49.lbl f004a47_isis3_67.lbl f004a47_isis3_85.lbl
f004a47_isis3_13.lbl f004a47_isis3_32.lbl f004a47_isis3_50.lbl f004a47_isis3_68.lbl f004a47_isis3_86.lbl
f004a47_isis3_14.lbl f004a47_isis3_33.lbl f004a47_isis3_51.lbl f004a47_isis3_69.lbl f004a47_isis3_87.lbl
f004a47_isis3_15.lbl f004a47_isis3_34.lbl f004a47_isis3_52.lbl f004a47_isis3_70.lbl f004a47_isis3_88.lbl
f004a47_isis3_16.lbl f004a47_isis3_35.lbl f004a47_isis3_53.lbl f004a47_isis3_71.lbl f004a47_isis3_89.lbl
f004a47_isis3_17.lbl f004a47_isis3_36.lbl f004a47_isis3_54.lbl f004a47_isis3_72.lbl f004a47_isis3_90.lbl
f004a47_isis3_18.lbl f004a47_isis3_37.lbl f004a47_isis3_55.lbl f004a47_isis3_73.lbl f004a47_isis3_91.lbl
f004a47_isis3_19.lbl f004a47_isis3_38.lbl f004a47_isis3_56.lbl f004a47_isis3_74.lbl f004a47_isis3_92.lbl
f004a47_isis3_2.lbl f004a47_isis3_39.lbl f004a47_isis3_57.lbl f004a47_isis3_75.lbl f004a47_isis3_93.lbl
f004a47_isis3_20.lbl f004a47_isis3_40.lbl f004a47_isis3_58.lbl f004a47_isis3_76.lbl f004a47_isis3_94.lbl
f004a47_isis3_21.lbl f004a47_isis3_41.lbl f004a47_isis3_59.lbl f004a47_isis3_77.lbl f004a47_isis3_95.lbl
f004a47_isis3_22.lbl f004a47_isis3_42.lbl f004a47_isis3_60.lbl f004a47_isis3_78.lbl f004a47_isis3_96.lbl
f004a47_isis3_23.lbl f004a47_isis3_43.lbl f004a47_isis3_61.lbl f004a47_isis3_79.lbl f004a47_isis3_97.lbl
f004a47_isis3_24.lbl f004a47_isis3_44.lbl f004a47_isis3_62.lbl f004a47_isis3_80.lbl f004a47_isis3_98.lbl
f004a47_isis3_25.lbl f004a47_isis3_45.lbl f004a47_isis3_63.lbl f004a47_isis3_81.lbl f004a47_isis3_99.lbl
f004a47_isis3_26.lbl f004a47_isis3_46.lbl f004a47_isis3_64.lbl f004a47_isis3_82.lbl
```

# Prototype Review

```
austin@Austin: ~/ale/webservi x austin@Austin: ~/ale/websen x + v
Group = Kernels
NaifFrameCode          = -27001
CameraVersion          = 1
LeapSecond             = $base/kernels/lsk/naif0012.tls
TargetAttitudeShape    = $base/kernels/pck/pck00009.tpc
TargetPosition         = ($base/kernels/spk/de430.bsp,
                        $base/kernels/spk/mar097.bsp)
InstrumentPointing      = ($viking1/kernels/ck/vo1_sedr_ck2.bc,
                        $viking1/kernels/fk/vo1_v10.tf)
Instrument              = Null
SpacecraftClock         = ($viking1/kernels/sclk/vo1_fict.tsc,
                        $viking1/kernels/sclk/vo1_fsc.tsc)
InstrumentPosition      = $viking1/kernels/spk/viking1a.bsp
InstrumentAddendum      = $viking1/kernels/iak/vikingAddendum003.ti
ShapeModel              = $base/dems/molaMarsPlanetaryRadius0005.cub
InstrumentPositionQuality = Reconstructed
InstrumentPointingQuality = Reconstructed
Source                 = ale
End_Group
This function(PvlObject::addLogGroup) will be depreciated in ISIS3 v9.0 in favor of Application::appendLogGroup
Attempting to pre-parse label file
Successfully pre-parsed label file
Trying <class 'ale.drivers.dawn_drivers.DawnFcIsisLabelNaifSpiceDriver'>
Failed: 'FilterNumber'

Traceback (most recent call last):
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/__init__.py", line 154, in load
    res.instrument_id
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/dawn_drivers.py", line 236, in instru
ment_id
```

# Prototype Review

```
austin@Austin: ~/ale/webservi x austin@Austin: ~/ale/websen x + v
File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/mex_drivers.py", line 509, in instrument_id
    raise Exception("Instrument ID is wrong.")
Exception: Instrument ID is wrong.
Trying <class 'ale.drivers.mex_drivers.MexHrscPds3NaifSpiceDriver'>
Failed: 'INSTRUMENT_ID'

Traceback (most recent call last):
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/__init__.py", line 154, in load
    res.instrument_id
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/mex_drivers.py", line 157, in instrument_id
    if(super().instrument_id != "HRSC"):
      ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/base/label_pds3.py", line 33, in instrument_id
    return self.label['INSTRUMENT_ID']
           ~~~~~^~~~~~
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/pvl/collections.py", line 175, in __getitem__
    return dict_getitem(self, key)[0]
           ~~~~~^~~~~~
KeyError: 'INSTRUMENT_ID'
Trying <class 'ale.drivers.mex_drivers.MexSrcPds3NaifSpiceDriver'>
Failed: 'INSTRUMENT_ID'

Traceback (most recent call last):
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/__init__.py", line 154, in load
    res.instrument_id
```

# Prototype Review

```
austin@Austin: ~/ale/webservi x austin@Austin: ~/ale/websen x + v
Trying <class 'ale.drivers.viking_drivers.VikingIisLabelIisSpiceDriver'>
Success with: <ale.drivers.viking_drivers.VikingIisLabelIisSpiceDriver object at 0x7fabdb2eb450>

ISD:
{
  "isis_camera_version": 1,
  "image_lines": 1056,
  "image_samples": 1205,
  "name_platform": "VIKING_ORBITER_1",
  "name_sensor": "Visual Imaging Subsystem Camera A",
  "reference_height": {
    "maxheight": 1000,
    "minheight": -1000,
    "unit": "m"
  },
  "name_model": "USGS_ASTRO_FRAME_SENSOR_MODEL",
  "center_ephemeris_time": -742324625.5606928,
  "radii": {
    "semimajor": 3396.19,
    "semiminor": 3376.2,
    "unit": "km"
  },
  "body_rotation": {
    "time_dependent_frames": [
      10014,
      1
    ],
    "ck_table_start_time": -742324621.5706928,
    "ck_table_end_time": -742324621.5706928,
    "ck_table_original_size": 1,
```


# Prototype Review


```
austin@Austin: ~/ale/webservei X austin@Austin: ~/ale/webservei X + v
(isis) austin@Austin:~/ale/webservei/Cloud-Based-Planetary-Ephemerides/API/returned_isds$ ls
005a11f006b0cf1c8dd7e43117f4376cf4c0246dc3352da9962ff6e220e58e8a_isd.json
01f98df302a188c315aaf3f636dfc64826afed4829938f1b4df482681298f775_isd.json
02724a57f01ef966f29dbf8ebb43e4e84623ed94847882a5c99a7d4ded3d53e5_isd.json
03b5a9b912f2921a0d0be07105e7cc9b2bbaef90c9ad777b32aae9d5042b3b6_isd.json
044a035d619c5900df2c21f7278733187786acff030526d8a5c13a0e5a4ae418_isd.json
08ab08a94f886bdebd11ff7240bb6a0e156cf93ca66b0bb4a3caf15b1b14b297_isd.json
0a2ef692132d328169cddbdc55c97fbf9c13ae5db70237fe87700d024c547af9_isd.json
0b23a6482443002235856a9adfb9be9b712bb9f145917ec8b3939115b1b9b6bb_isd.json
0b391e997f703aa58dc38f48573d5c1a521ef8f048ca35d7bff135cff93c22e5_isd.json
16b7218c7b5f0b700a8d5b46e508195e9ff9db0cb3fe4262cc5c476b0df60f51_isd.json
1cf761e9292963ae33b9b5a0999d27098fbfa87969aa21d97d311317a07fae7_isd.json
21259a8eda14742eeb649bb04d6754c5b9d6119cea64cb8eb71054509e317fffb_isd.json
23b7879ca76b789e2f697caee130a58975b18166728f09a0c591c54219116170_isd.json
262ca5d781a3d16f388b2fbac47922adad401a93553df616def7e2c7df444b67_isd.json
263c59a403f41bc9fa72d4e1f0c97c65d6f3812f95306b9303d74c32c5d0b130_isd.json
2a777d4dbb2f96bfdbc5f5705fd11259decce4881aa332d09d0b2037006d4bce_isd.json
2d446179d494cf497ef7ef44faef8a68f451364be6587cd7023bc7389792f95d_isd.json
2d846f21abf38e0e1ef518ba26d3ee8570f854728f276fb753a1eb0f57ea89aa_isd.json
3059842203f122424acb70cbf0151f352573257c53406625507b69321e38e670_isd.json
30bbb2800d1a1cef02738436759515be6fde532d1aa56fdb3625e22c70aaef9_isd.json
37cecf73795c0979286adabb72ec1b969b19a348b2e88b8d2420706b3e0f0bd8_isd.json
38abecad01f8d3c766f3dce5dc250f3047e77c5a2fab6dc9941e56dea12a8121_isd.json
39dcc89deef7c432a6ad9db3d66bbd090241799d78f283c461c0e0adab31b68c6d_isd.json
3a0ca73d3e74f07e971897f2f3c002f17fcdcdfb26160543b6bc422c815f3fe9_isd.json
3ab959731ec616082ef795dd892c2db78884f6a5e4f6052c770924ef56c6a726_isd.json
3dd081bdd54721e342742506c40545df2350169c8f5f039447b6e325bc88709d_isd.json
41a5809fd71e54bf1c16b70f60e8f811e3d7277838dea221bbc93d287adadf3e_isd.json
432930231d5773bc275d285e1457bd6c51b7d15022eab0fc3d003165401d005e_isd.json
43f3c03d13767f82ca4a01321570e675964c4e0e10d5423d4753ffa43078bce8_isd.json
```

# Prototype Review

Get live item count

When you choose "Start scan," you will perform a DynamoDB scan to determine the most-recent item count. This scan might consume additional table read capacity units.

 It is not recommended to perform this action on very large tables or tables that serve critical production traffic. You can pause the action at any time to avoid consuming extra read capacity.

<b>Item count</b> 100	<b>Scan status</b>  Complete	<b>Last updated</b> April 10, 2025 12:18:46
--------------------------	--	--

Scan again

Cancel

# Prototype Review

```
austin@Austin: ~/ale/webse... x austin@Austin: ~/ale/webse... x + v
(isis) austin@Austin:~/ale/websevice/Cloud-Based-Planetary-Ephemerides/API$ python get_isd.py f004a47_isis3_0.lbl

Traceback (most recent call last):
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/__init__.py", line 154, in load
    res.instrument_id
  File "/home/austin/miniforge3/envs/isis/lib/python3.11/site-packages/ale/drivers/lro_drivers.py", line 900, in instrument_id
    return id_lookup[super().instrument_id]
           ~~~~~~ ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
KeyError: 'VISUAL_IMAGING_SUBSYSTEM_CAMERA_A'
Trying <class 'ale.drivers.viking_drivers.VikingIsisLabelIsisSpiceDriver'>
Success with: <ale.drivers.viking_drivers.VikingIsisLabelIsisSpiceDriver object at 0x7f335a338b10>
ISD:
{
  "isis_camera_version": 1,
  "image_lines": 1056,
  "image_samples": 1205,
  "name_platform": "VIKING_ORBITER_1",
  "name_sensor": "Visual Imaging Subsystem Camera A",
  "reference_height": {
    "maxheight": 1000,
    "minheight": -1000,
    "unit": "m"
  }
}
```

```
austin@Austin: ~/ale/websevice/Cloud-Based-Planetary-Ephemerides/API/returned_isds$ ls
f0b2800ecde151ff8020311f3fe0c4642ff8c520e1ab2b6c922411af95fd6a64_isd.json
(isis) austin@Austin:~/ale/websevice/Cloud-Based-Planetary-Ephemerides/API/returned_isds$ |
```



# Challenges and Resolutions

## AWS Implementation Challenges

- **Problem:** We needed to implement our system on AWS for scalability, but there was little to no comprehensive documentation. Even the available resources online were often outdated, making navigation difficult.
- **Solution:** We tackled this by piecing together information from multiple sources, leveraging AWS support forums, and experimenting with AWS services in a controlled test environment.

## ISIS and ALE System Navigation

- **Problem:** Understanding and integrating ISIS and NASA's ALE tool had been challenging due to complex documentation and the steep integration.
- **Solution:** We created internal documentation, ran test cases, and consulted with experts to streamline the integration process.

## Hash Scheme and GET Request Limitations

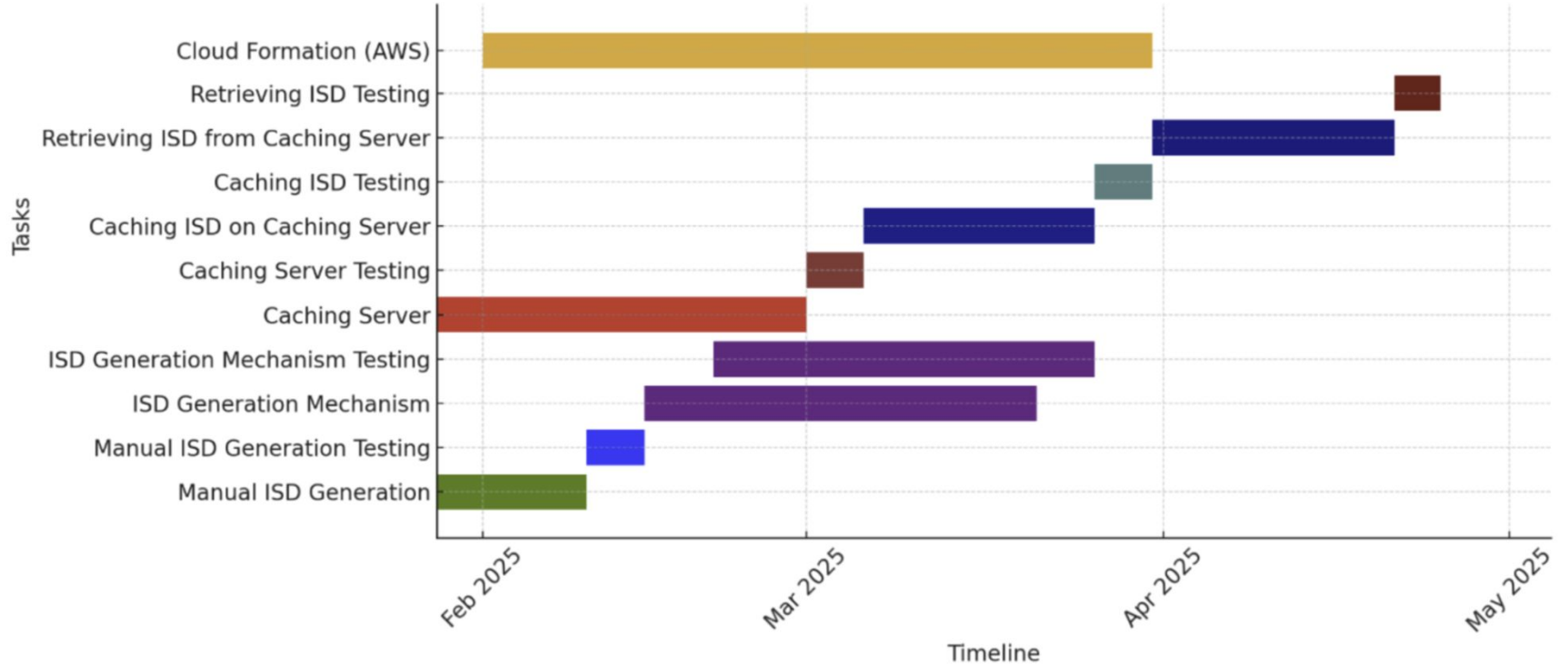
- **Problem:** We needed to implement a hashing scheme for ID retrieval via FastAPI, but had to ensure that the generated hash fit within the GET request limits.
- **Solution:** We researched different hashing algorithms to balance efficiency and size constraints, ensuring compatibility with FastAPI's single endpoint approach for ID retrieval.



# Testing Plan

- Beta Prototype deployed and under test
- Unit tests: key functions (parsing, hashing, endpoints)
- Integration tests: FastAPI to SPICE to DynamoDB and back
- Usability testing: API experience for researchers
- Refinements ongoing

# Schedule



# Conclusion

- We are developing a Web Service and Caching Server for USGS and NASA
- Solution allows easy generation, querying and retrieval of ISDs
- Potential risks are still both scalability and accuracy related
- Currently testing the product in preparation for delivery of final product in May