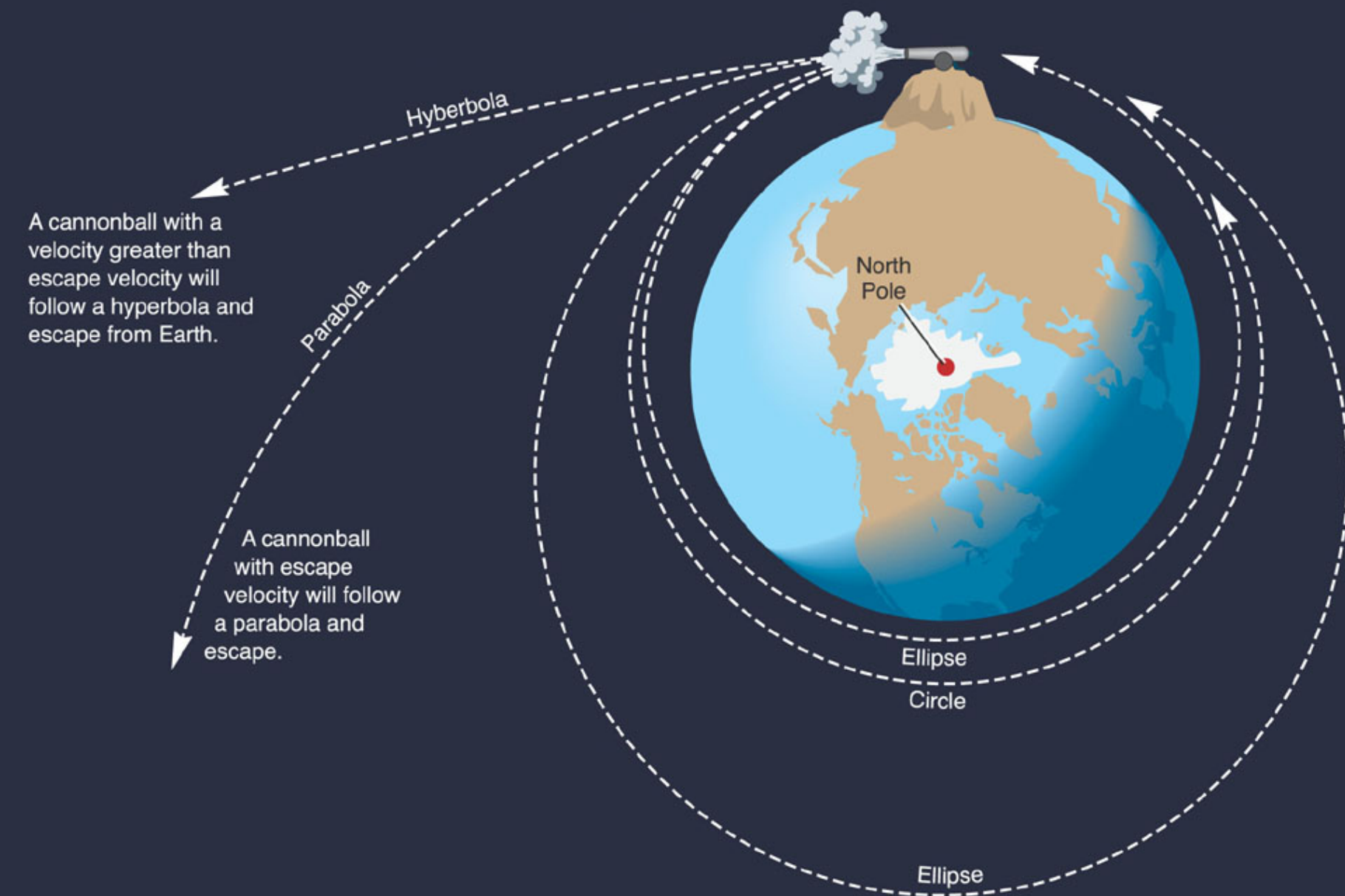




SPLASHDOWN VISUALIZATION OF SPENT STAGES

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Purpose

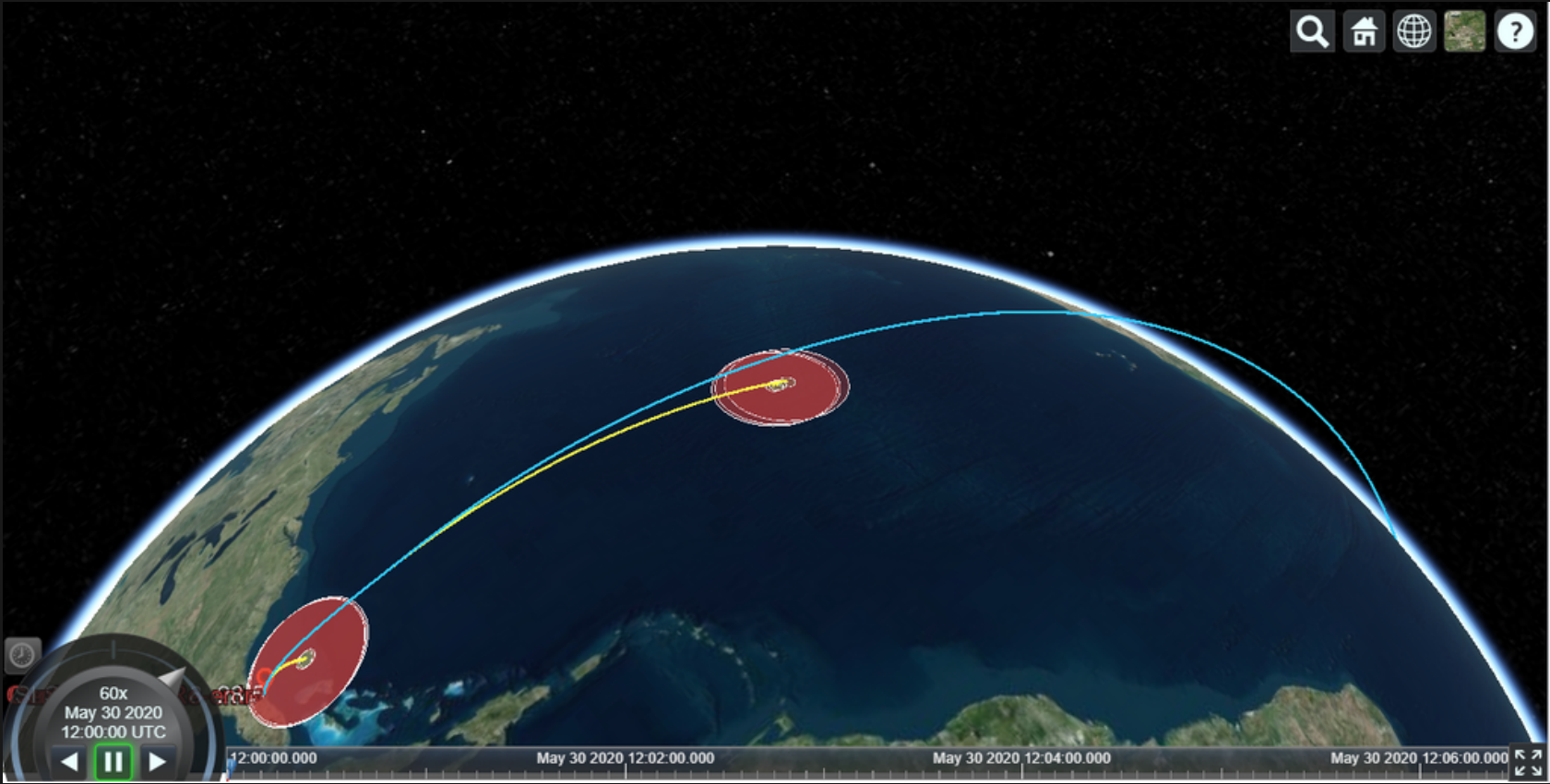
- Develop capability to visualize various 3DoF (3 degrees of freedom) Earth-to-orbit trajectories from data outputs of standard trajectory analysis tools (i.e. POST, or Program to Optimize Simulated Trajectories) for any launch vehicle concept
 - Demonstrate re-entry points of vehicle stages
 - Show trajectories of multiple launch vehicles and their launch sites
 - Show 3D models of various launch vehicles and key information and various points in trajectory
- Some NASA requirements dictate that trajectories be designed such that no surviving debris lands closer than 200 nautical miles (nm) from foreign landmasses or 27 nm from the continental United States

POST DATA

	time	alpha	xmx1	gdalt	qalpha	yxmx1	weight	mach	xmx2
1	0.000000000000e+00	9.000000000000e+01	2.094344660828860e-04	2.039214230373755e-09	1.884910194745974e-02	0.000000000000e+00	6.		
2	5.000000000000e-01	8.99999999994031e+01	2.094344660941394e-04	-2.039214230373754e-09	1.884910194844752e-02	5.000000000000e-01	6		
3	5.000000000000e-01	9.000168207050700e+01	2.094344660941394e-04	-2.039214230373754e-09	1.884945423199858e-02	5.000000000000e-01	6		
4	1.000000000000e+00	3.304635965082423e+00	2.848050353880589e-02	1.184300795015104e+00	9.411769629799516e-02	1.000000000000e+00	6.		
5	1.000000000000e+00	3.304635965082423e+00	2.848050353880589e-02	1.184300795015104e+00	9.411769629799516e-02	1.000000000000e+00	6.		
6	2.000000000000e+00	9.577698485866313e-01	2.651331610599620e-01	1.109516221300840e+01	2.539365475236948e-01	2.000000000000e+00	6.		
7	3.000000000000e+00	4.249129996875471e-01	7.480186589269207e-01	3.111754651887890e+01	3.178428521868941e-01	3.000000000000e+00	6.		
8	4.000000000000e+00	1.464555270726490e-01	1.491265817790311e+00	6.140528384567767e+01	2.184041213499050e-01	4.000000000000e+00	6.		
9	5.000000000000e+00	-4.660388289590467e-02	2.519324657542458e+00	1.022018958404093e+02	-1.174103113168739e-01	5.000000000000e+00			
10	6.000000000000e+00	-1.996373743844776e-01	3.867767913220883e+00	1.538669293290053e+02	-7.721510309239471e-01	6.000000000000e+00			
11	7.000000000000e+00	-3.298620803717001e-01	5.579489325970834e+00	2.168588838552665e+02	-1.840461956476434e+00	7.000000000000e+00			
12	8.000000000000e+00	-4.454598166596815e-01	7.696815145671443e+00	2.916965021889080e+02	-3.428621863654261e+00	8.000000000000e+00			
13	9.000000000000e+00	-5.519310810042857e-01	1.021829402881786e+01	3.788303764504798e+02	-5.639794069345077e+00	9.000000000000e+00			
14	1.000000000000e+01	-6.520725441292297e-01	1.315535244118174e+01	4.785525614297233e+02	-8.578244135238052e+00	1.000000000000e+01			
15	1.001406552527643e+01	-6.534424617485913e-01	1.319979074741655e+01	4.800464601954141e+02	-8.625303760558149e+00	1.001406552527643e+01			
16	1.001406552527643e+01	-6.534424617485913e-01	1.319979074741655e+01	4.800464601954141e+02	-8.625303760558149e+00	1.001406552527643e+01			
17	1.100000000000e+01	-1.172278107312086e+00	1.654509941351526e+01	5.911882639104617e+02	-1.939545782576597e+01	1.100000000000e+01			
18	1.200000000000e+01	-1.530228732256382e+00	2.043431943091884e+01	7.171432549211395e+02	-3.126918271729689e+01	1.200000000000e+01			
19	1.300000000000e+01	-1.764094642692297e+00	2.485298191095017e+01	8.568582600896171e+02	-4.384301224403575e+01	1.300000000000e+01			
20	1.400000000000e+01	-1.906266912928190e+00	2.982311171862781e+01	1.010773028151679e+03	-5.685081110978116e+01	1.400000000000e+01			
21	1.500000000000e+01	-1.980644351197880e+00	3.53439173360930e+01	1.179243330202636e+03	-6.998486339018633e+01	1.500000000000e+01			
22	1.600000000000e+01	-2.003632414902186e+00	4.140807875221796e+01	1.362590174542762e+03	-8.296656882676639e+01	1.600000000000e+01			
23	1.700000000000e+01	-1.987488567457889e+00	4.806510445098308e+01	1.561140587707980e+03	-9.552884558999814e+01	1.700000000000e+01			
24	1.800000000000e+01	-1.941538144769325e+00	5.532666575726932e+01	1.775224988749174e+03	-1.074188319906372e+02	1.800000000000e+01			
25	1.900000000000e+01	-1.872837497970126e+00	6.322791455696293e+01	2.005191370138315e+03	-1.184156093007314e+02	1.900000000000e+01			
26	2.000000000000e+01	-1.786972078818441e+00	7.181601274555103e+01	2.251429306536485e+03	-1.283332095883690e+02	2.000000000000e+01			
27	2.100000000000e+01	-1.688714259463787e+00	8.112880283255848e+01	2.514371347791035e+03	-1.370033661965675e+02	2.100000000000e+01			
28	2.200000000000e+01	-1.582159095633739e+00	9.117693523846495e+01	2.794442389406719e+03	-1.442564173995457e+02	2.200000000000e+01			
29	2.300000000000e+01	-1.470309449886972e+00	1.020047985325907e+02	3.092074968956188e+03	-1.499786192162849e+02	2.300000000000e+01			
30	2.400000000000e+01	-1.380327395362522e+00	1.136058935180190e+02	3.407725404640553e+03	-1.568133270975592e+02	2.400000000000e+01			
31	2.500000000000e+01	-1.324439273525198e+00	1.259635563854737e+02	3.741830626073384e+03	-1.668310811098270e+02	2.500000000000e+01			
32	2.600000000000e+01	-1.266401168208638e+00	1.389986810498726e+02	4.094786066215868e+03	-1.760280920610185e+02	2.600000000000e+01			
33	2.682634426409498e+01	-1.218489963301656e+00	1.500000001982023e+02	4.400697005518678e+03	-1.827734947367558e+02	2.682634426409498e+01			
34	2.682634426409498e+01	-1.218489963301656e+00	1.500000001982023e+02	4.400697005518678e+03	-1.827734947367414e+02	2.682634426409498e+01			
35	2.700000000000e+01	-1.176170409047681e+00	1.523306711653339e+02	4.466610101649754e+03	-1.791668278150384e+02	2.700000000000e+01			
36	2.800000000000e+01	-9.324724163872414e-01	1.658588264663130e+02	4.857068655512046e+03	-1.546587806941950e+02	2.800000000000e+01			
37	2.900000000000e+01	-6.887744237270098e-01	1.796051754082763e+02	5.265972703350544e+03	-1.237074511902240e+02	2.900000000000e+01			
38	3.000000000000e+01	-4.450764310666714e-01	1.935494364168999e+02	5.693224494100090e+03	-8.614429239539942e+01	3.000000000000e+01			
39	3.100000000000e+01	-2.013784384063554e-01	2.076517677819532e+02	6.138733410147539e+03	-4.181658872824887e+01	3.100000000000e+01			
40	3.182634426409498e+01	-3.622758710061674e-14	2.194261748321817e+02	6.520621537281392e+03	-7.949280860888021e-12	3.182634426409498e+01			
41	3.182634426409498e+01	-7.192163094496519e-14	2.194261748321817e+02	6.520621537281392e+03	-1.578148836594558e-11	3.182634426409498e+01			
42	3.200000000000e+01	-8.127731792094432e-14	2.219173253542668e+02	6.602455360639920e+03	-1.803684500498438e-11	3.200000000000e+01			
43	3.300000000000e+01	-7.457716875236590e-14	2.363619913930917e+02	7.084356318945214e+03	-1.762720811876786e-11	3.300000000000e+01			
44	3.400000000000e+01	-7.989013914995480e-14	2.509206355933584e+02	7.584386163170050e+03	-2.004608449314851e-11	3.400000000000e+01			
45	3.500000000000e+01	-3.240635520455722e-14	2.655548002685088e+02	8.102508541862300e+03	-8.605663183776544e-12	3.500000000000e+01			
46	3.600000000000e+01	6.273059444490954e-16	2.802280637362100e+02	8.638679345480856e+03	1.757887301831845e-13	3.600000000000e+01	5.		
47	3.700000000000e+01	-3.097574960744577e-14	2.949126443786591e+02	9.192858059998167e+03	-9.135140228343044e-12	3.700000000000e+01			
48	3.800000000000e+01	3.729578957908811e-15	3.095521547074088e+02	9.764999821843250e+03	1.154499202572085e-12	3.800000000000e+01	5.		
49	3.900000000000e+01	-8.182334425483926e-14	3.241979308582659e+02	1.035503157881403e+04	-2.652695890332247e-11	3.900000000000e+01			
50	4.000000000000e+01	-8.276132635560149e-14	3.387418833863642e+02	1.096287732240124e+04	-2.803472756124999e-11	4.000000000000e+01			
51	4.100000000000e+01	-5.629911216360506e-14	3.531294511679783e+02	1.158845068653366e+04	-1.988087457957831e-11	4.100000000000e+01			
52	4.200000000000e+01	-4.365342030877435e-14	3.673347401198029e+02	1.223166463107712e+04	-1.603541780446415e-11	4.200000000000e+01			
53	4.300000000000e+01	-5.066158259634095e-14	3.813200403311341e+02	1.289242842034282e+04	-1.931827671887582e-11	4.300000000000e+01			
54	4.400000000000e+01	-6.195926000039304e-14	3.950837805821145e+02	1.357064944532269e+04	-2.447909868302547e-11	4.400000000000e+01			
55	4.500000000000e+01	-6.426724531879765e-14	4.086006208565824e+02	1.426624407392975e+04	-2.625963633800301e-11	4.500000000000e+01			
56	4.600000000000e+01	-3.066442380273560e-14	4.218701286171781e+02	1.497913422455386e+04	-1.293640441363173e-11	4.600000000000e+01			
57	4.700000000000e+01	-3.888867517904978e-14	4.349249414585472e+02	1.570929005519133e+04	-1.691365477564868e-11	4.700000000000e+01			
58	4.800000000000e+01	-1.453932878771003e-14	4.477031643195628e+02	1.645668639254115e+04	-6.509303505340296e-12	4.800000000000e+01			
59	4.900000000000e+01	-7.73437171316551e-15	4.590866500817309e+02	1.722130153160250e+04	-1.757757807321786e-12	4.900000000000e+01			



3D VISUALIZATION



Methodology



django

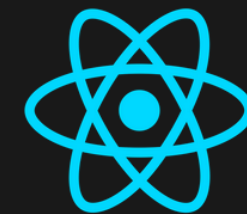
RELATIONAL DATABASE FOR STORING DATA

Used Django for back-end framework, as well as Python libraries like Pandas for handling data



VISUALIZATION PACKAGE

Used CesiumJS, a JavaScript library which includes a high resolution globe and many capabilities for plotting orbital paths and more



EASY TO USE

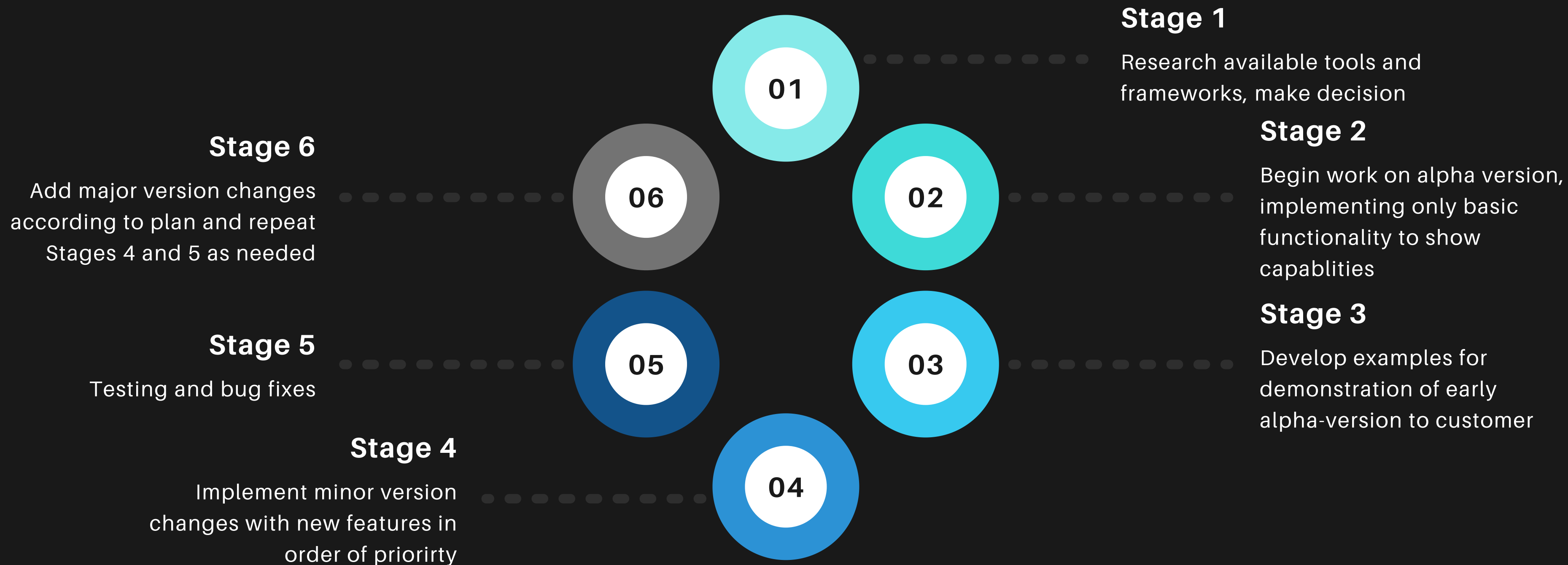
Use modern front-end framework and choose a layout that is effective but simple.



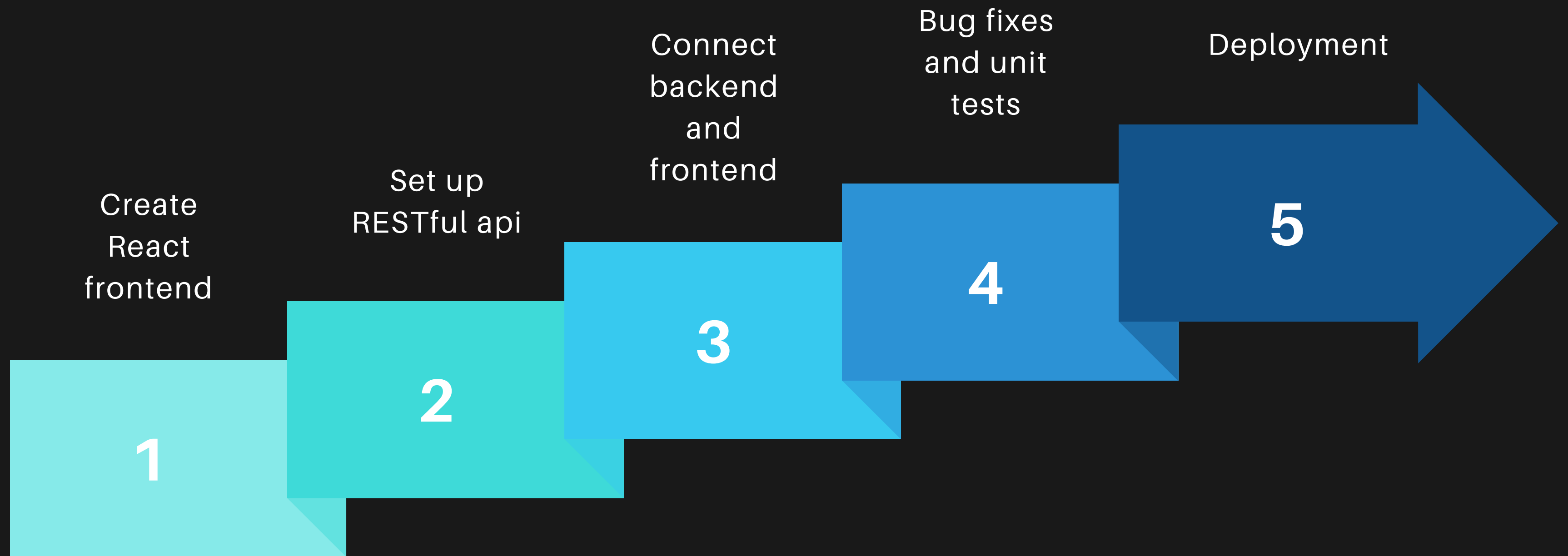
EFFICIENCY

Make sure software is lightweight and fast, and has features that are desired and useful for the analyst and programmatic level.

ALPHA DEVELOPMENT CYCLE

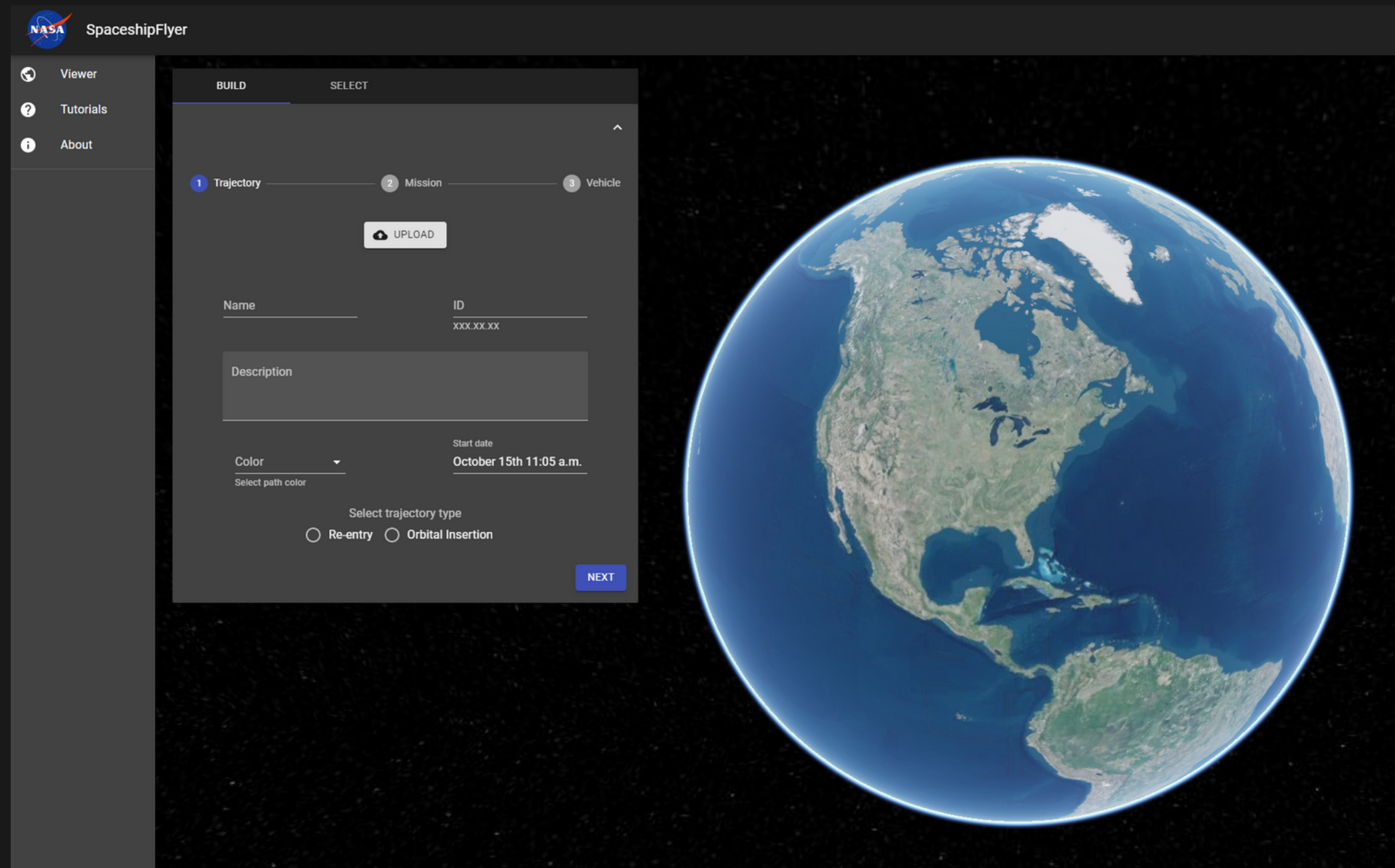


PATH TO BETA RELEASE

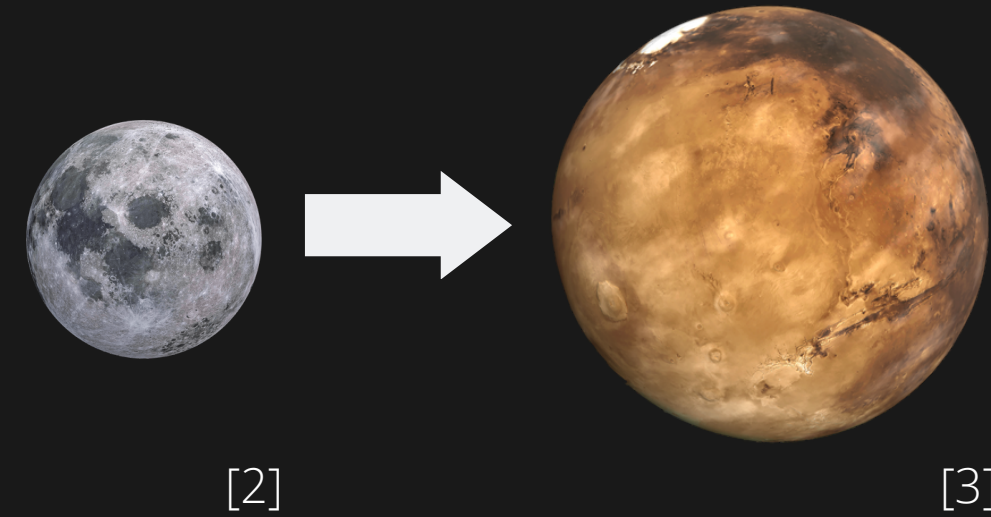


Current Status

- Currently on Step 4 of the previous slide, nearing Beta release and deployment



Future Work



- Capability to visualize end-to-end trajectory data from other analysis tools around other bodies (i.e. the moon and Mars)
- Additional interactable windows for more insight into trajectory information
 - Analysis plots (thrust, acceleration, etc.) and live geospatial updates (altitude)
 - Vehicle stages and engine display with images

References

1. Peet, A.W. (2014). Escape velocity [Digital image]. Retrieved from <https://ap.io/mpip/05/>
2. Revera, G.H. (2010). Full moon [Digital Image]. Retrieved from <https://en.wikipedia.org/wiki/Moon#/media/File:FullMoon2010.jpg>
3. ESA & MPS for OSIRIS Team (2007). Mars [Digital Image]. Retrieved from https://upload.wikimedia.org/wikipedia/commons/0/02/OSIRIS_Mars_true_color.jpg