Interactive Client-Side Mapping with the ArcGIS API for JavaScript

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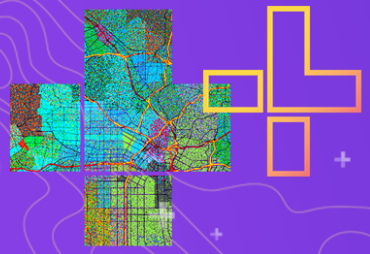
`https://git.io/JvB8u (printer friendly, pdf)`



Agenda

- Client-side Layers
  - FeatureLayer, CSVLayer, GeoJSONLayer
- Query
  - Layer vs LayerView
  - Client-side query
- Filters and Effects
  - Adjusting client-side visuals
- Geometry Engine, Projection Engine and Geodesic Utils
  - Client-side analysis

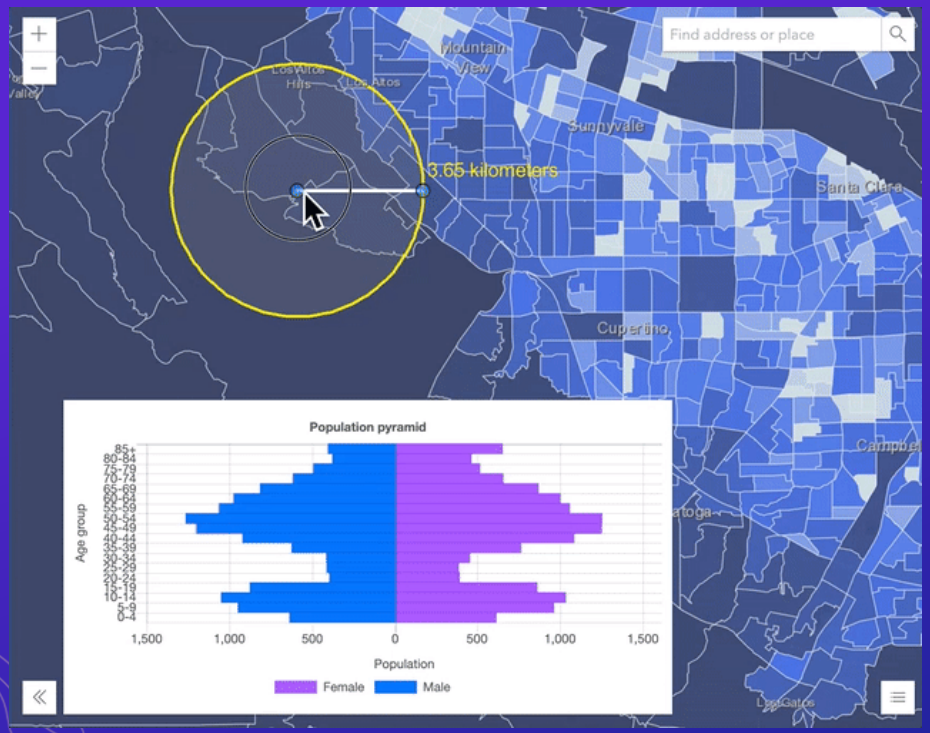
Client-side Layers

Client-side Layers

- CSVLayer
- GeoJSONLayer
- FeatureLayer with feature collections.

Client-side Layers

- Fetch all features at once and store them on the client
- Uniform API
- Responsive and fast performance



CSVLayer

- Add data from csv/txt file as points

```
const new CSVLayer({
  url: "https://earthquake.usgs.gov/earthquakes/.../2.5_week.csv",
  copyright: "USGS Earthquakes",
  // SR in which the data will be stored
  spatialReference: { wkid: 102100 },
  delimiter: ",",
  latitudeField: "lat",
  longitudeField: "lon",
  // defaults to "__OBJECTID"
  objectIdField: "myOid",
  // create timeInfo for temporal visualization
  timeInfo: {
    startField: "time", // name of the date field
    // set time interval to one day
    interval: { value: 1, unit: "days" },
  }
})
```

API Reference | Sample 1

CSVLayer - Tips

- X, Y coordinates must be in WGS84 in csv file.
- Specify the layer's spatial reference to improve the performance.
- Not supported:
  - No z-values support.
  - Cannot add, remove or update features.

CSVLayer - Tips

- Can pass data by a blob url.

```
const csv = `first_name|Year|latitude|Longitude
             Undral|2020|40.418|20.553
             Richie|2018|-118|35`;

const blob = new Blob([csv], {
  type: "plain/text"
});
let url = URL.createObjectURL(blob);

const layer = new CSVLayer({
  url: url
});
await layer.load();

URL.revokeObjectURL(url);
url = null;
```

FeatureLayer

- Add client-side graphics by setting *FeatureLayer.source*

```
const layer = new FeatureLayer({
  source: [
    new Graphic({ attributes: { myOid: 1 }, geometry: { ... } })
    new Graphic({ attributes: { myOid: 2 }, geometry: { ... } })
    new Graphic({ attributes: { myOid: 3 }, geometry: { ... } })
  ],
  // can be inferred from geometries
  geometryType: "point",
  // can be inferred from geometries
  spatialReference: { wkid: 2154 },
  // can be inferred from fields w/ field.type "oid"
  objectIdField: "myOid",

  fields: [
    new Field({ name: "myOid", type: "oid" })
  ]
})
```

FeatureLayer - Tips

- Supports data in any spatial reference.
- Specify *source* only at the time of initialization.
- Use FeatureLayer.applyEdits to add, remove or update features at runtime.
- Call FeatureLayer.queryFeatures to get the updated feature collection.

Sample - add/remove graphics

GeoJSONLayer

- Add GeoJson data that comply with the RFC 7946 specification

```
const geoJSONLayer = new GeoJSONLayer({
  url: "https://earthquake.usgs.gov/earthquakes/.../all_month.geojson",
  copyright: "USGS Earthquakes",
  // SR in which the data will be stored
  spatialReference: { wkid: 102100 }
});
```

API Reference | Time-aware GeoJSONLayer

GeoJSONLayer - Tips

- Specify layer's spatial reference for performance.
- Support for Feature and FeatureCollection
- GeoJSONLayer.applyEdits to add, delete or update features.
- Not supported:
  - Mixed geometry types for consistency with other layers.
  - `crs` object - only geographic coordinates using WGS84 datum (long/lat)
  - No Antimeridian crossing
  - Feature `id` as `string`

GeoJSONLayer - Tips

- Create a blob url from GeoJSON object

```
const geojson = `{
 type: "FeatureCollection",
 features: [{
   type: "Feature",
   geometry: { type: "Point", coordinates: [-100, 40] },
   properties: { name: "none" }
 }]
}`;

const blob = new Blob([JSON.stringify(geojson)], {
  type: "application/json"
});
let url = URL.createObjectURL(blob);
const layer = new GeoJSONLayer({ url });

await layer.load();
URL.revokeObjectURL(url);
url = null;
```

Client-side layers tips

- Each implementation uses the client-side query engine.
- Prefer `GeoJSON` over `CSV`.
- Proper attribution using `copyright` property.

Query

Query

- Query expressions are used to select a subset of features and table records.
- Query can be done on the server or on the client-side.
- Different `query...` methods are available on Layers and LayerViews.

Layers and Layer Views

- Server-side layers
  - Fetch or stream features on demand
  - FeatureLayer created from a service, SceneLayer
  - A LayerView represents the view for a single layer after it has been added to a View.
  - LayerView API is layer agnostic.
  - Methods and properties used for features available for drawing on the client-side.

Client-side query

- `(CSV|GeoJSON)Layer` and `FeatureLayer/FeatureCollection`
- `(CSV|GeoJSON|Feature|Scene|Stream)LayerView`
- Query methods on layer and layerView
  - `queryFeatures()`
  - `queryFeatureCount()`
  - `queryObjectIds()`
  - `queryExtent()`

Layer vs LayerView | Age Pyramid | 3D buildings

Query tips

When to use	Layer queries	LayerView queries
Speed and responseviness	No(server layer) Yes(client layers)	Yes. Client-side query
Query all features	Yes	No. Features available for drawing
Geometry precision	Yes	No. Quantized/generalized

Filters

What are filters?

- Reduce the number of features shown screen
- Can apply spatial, aspatial, temporal (or any combination)

```
featureLayerView.filter = new FeatureFilter({
  geometry: myGeometry       // Spatial
  timeExtent: myTimeExtent, // Temporal
  where: myWhere             // Aspatial
});
```

- Client-side
  - Only applied to features currently downloaded
  - Fast.
- FeatureFilter has the same properties as Query

Spatial Filter

Only show buildings within 10 miles of the mouse cursor

```
mapView.on("pointer-move", (event) => {
  buildingLayerView.filter = new FeatureFilter({
    geometry: mapView.toMap({
      event.x,
      event.y
    }),
    distance: 10,
    units: "miles"
  })
});
```

Aspatial Filter

Only show earthquakes with a magnitude greater than 7

```
featureLayerView.filter = new FeatureFilter({
  where: "magnitude >= 7"
});
```

Temporal Filter

Only show earthquakes that occured between 2000 and 2007

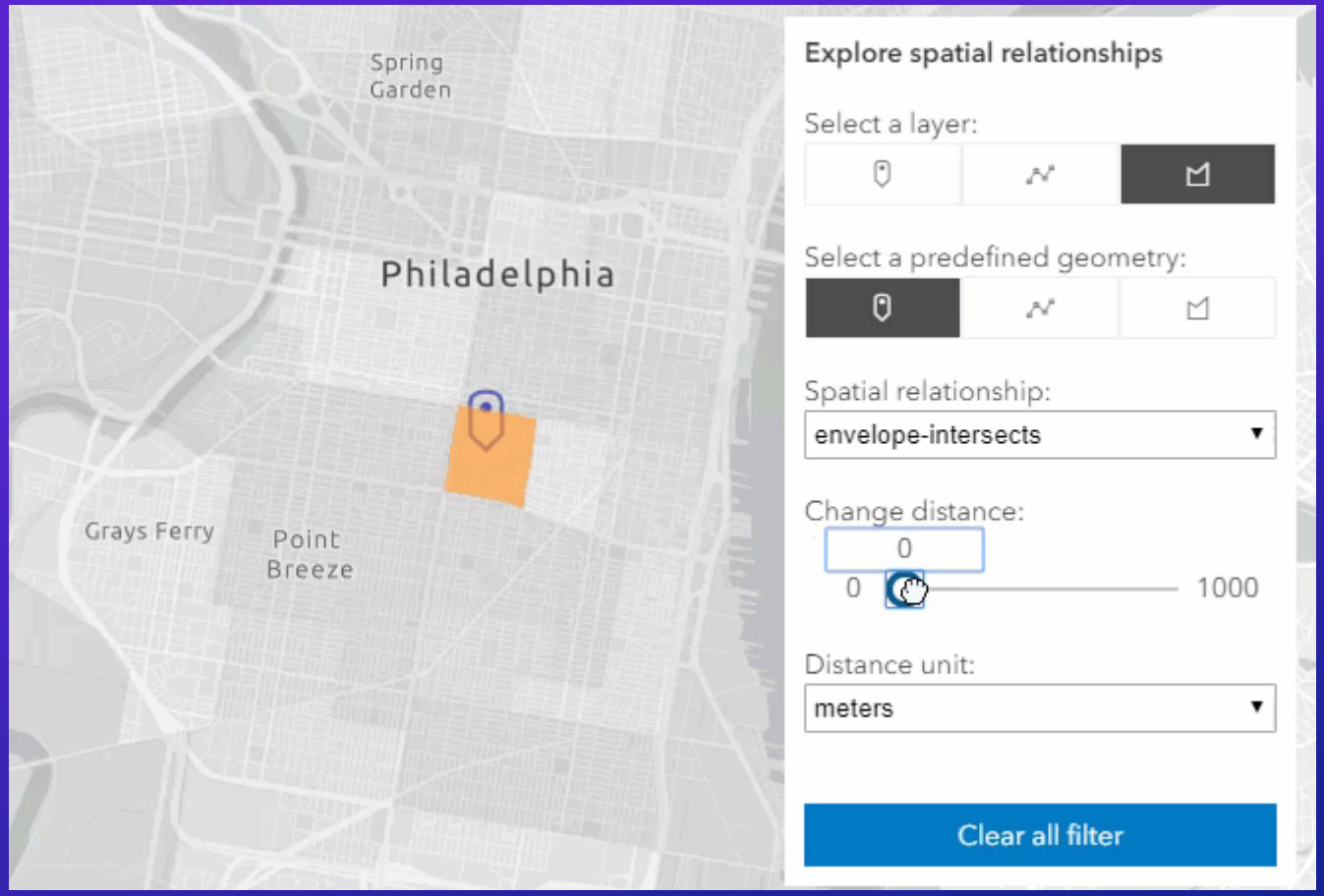
```
featureLayerView.filter = new FeatureFilter({
  timeExtent: new TimeExtent({
    start: new Date(2000, 0, 1),
    end: new Date(2007, 0, 1)
  })
});
```

Demonstration - filters

Effects

What are effects?

- Visual effects applied to included or excluded features.

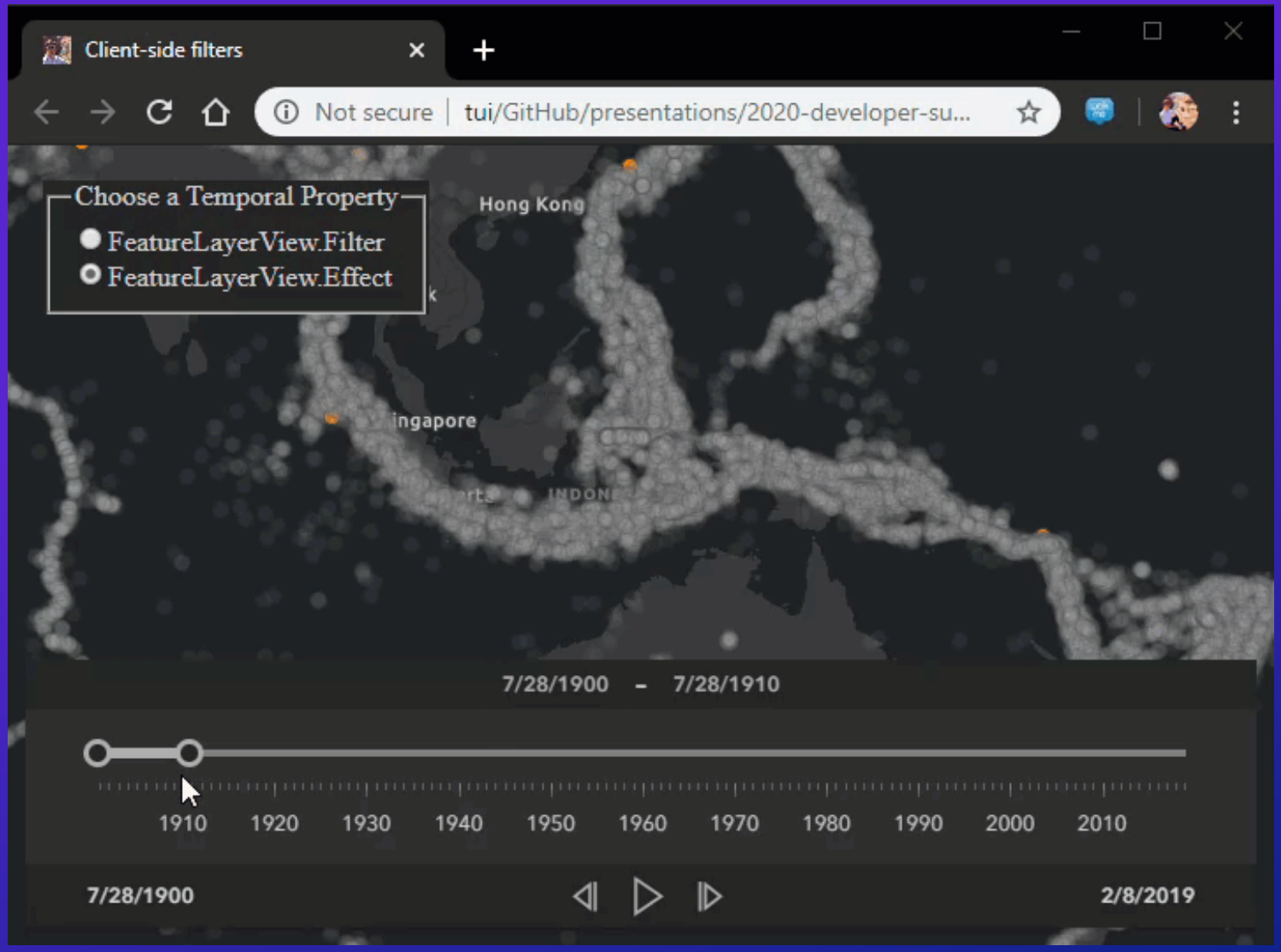


Effect - Snippet

Show earthquakes with a magnitude of 7 or greater as faint shadows

```
// Show quakes less than 7 magnitude as faint shadows.
featureLayerView.effect = new FeatureEffect({
  filter: new FeatureFilter({
    where: "magnitude >= 7"
  }),
  excludedEffect: "grayscale(100%) opacity(0.5)",
  // includedEffect: "saturate(150%)"
});
```

Demonstration - century of quakes



Supported Effects

```
/* effect(default-value) */
brightness(0.4);
contrast(200%);
grayscale(50%);
hue-rotate(90deg);
invert(75%);
opacity(25%);
saturate(30%);
sepia(60%);
```

CSS reference

Geometry Engine

One Engine - Thirty Methods

- Compute new geometries
  e.g. buffer, clip, densify, generalize
- Testing spatial relationship
  e.g. contains, crosses, intersects
- Advanced computations
  e.g. geodesicArea, planarArea

One Engine - Two Flavors

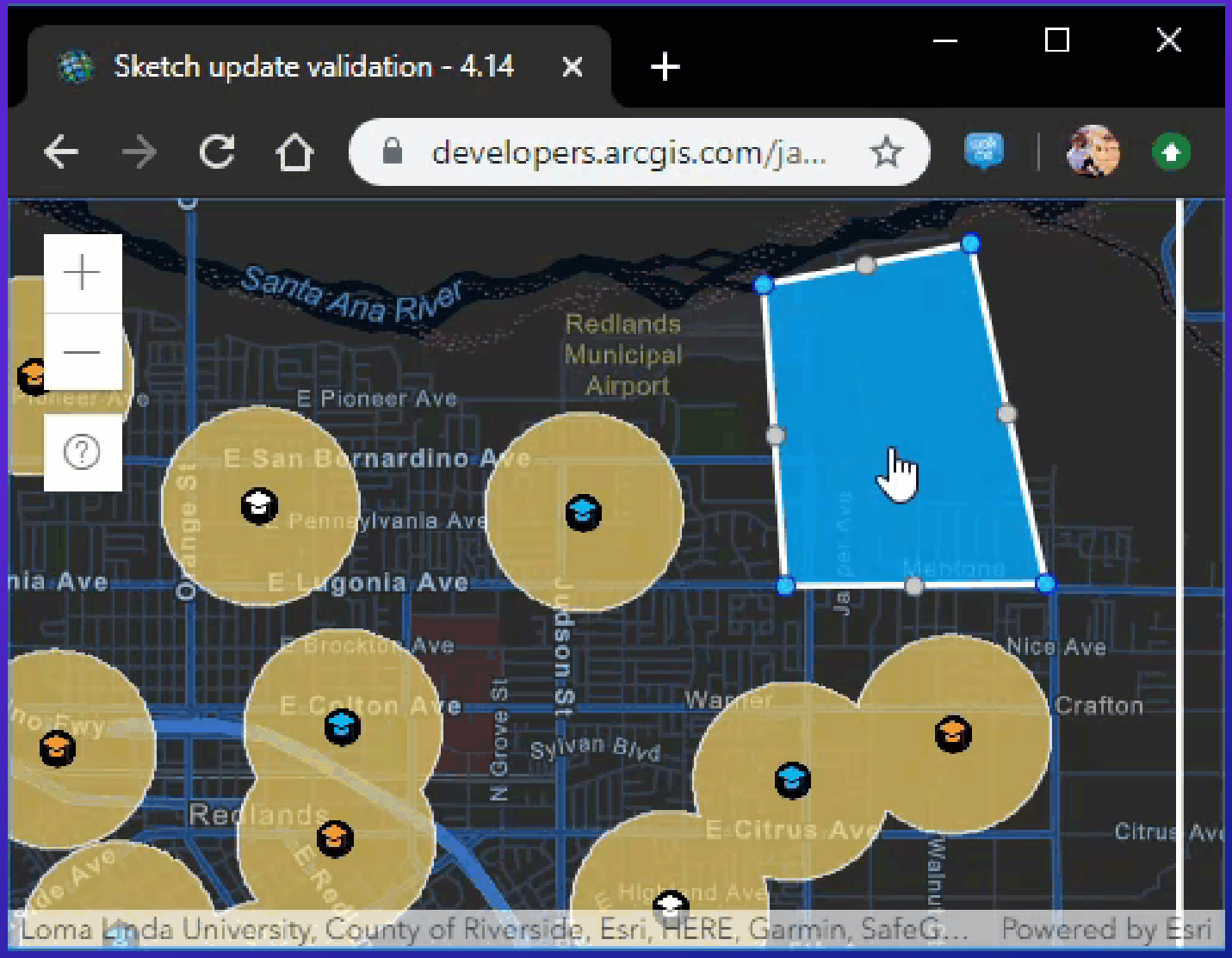
- geometryEngine

```
const geometryEngine = new GeometryEngine();
const length = geometryEngine.planarLength(myPolyline, "meters");
console.log("length(m)", length);
```

- geometryEngineAsync

```
const geometryEngine = new GeometryEngineAsync();
geometryEngine.planarLength(myPolyline, "meters").then((length) => {
  console.log("length(m)", length);
});
```

Demonstration - Sketch Validation



Wait, what about GeometryService?

- Same methods as GeometryEngine/GeometryEngineAsync
- Sends request to remote server for computation
- **Pro:**
  - May be faster for complex computations
- **Con:**
  - May be slower due to network latency

GeometryService - Snippet

```
const parameters = new LengthsParameters({
  calculationType: "planar",
  lengthUnit: "esriSRUnit_Meter",
  polylines: [myPolyline]
});

const geometryService = new GeometryService({
  url: "http://sampleserver6.arcgisonline.com/arcgis/rest/services/" +
       "Utilities/Geometry/GeometryServer"
});

geometryService.lengths(parameters).then((response) => {
    console.log("length(m)", response.lengths[0]);
});
```

Projection Engine

What is Projection Engine

- Client-side module for projecting geometries between coordinate systems
- Based on the engine used by Runtime
- Uses WebAssembly
  - Not support by Internet Explorer (see caniuse)

Loading the Projection Engine

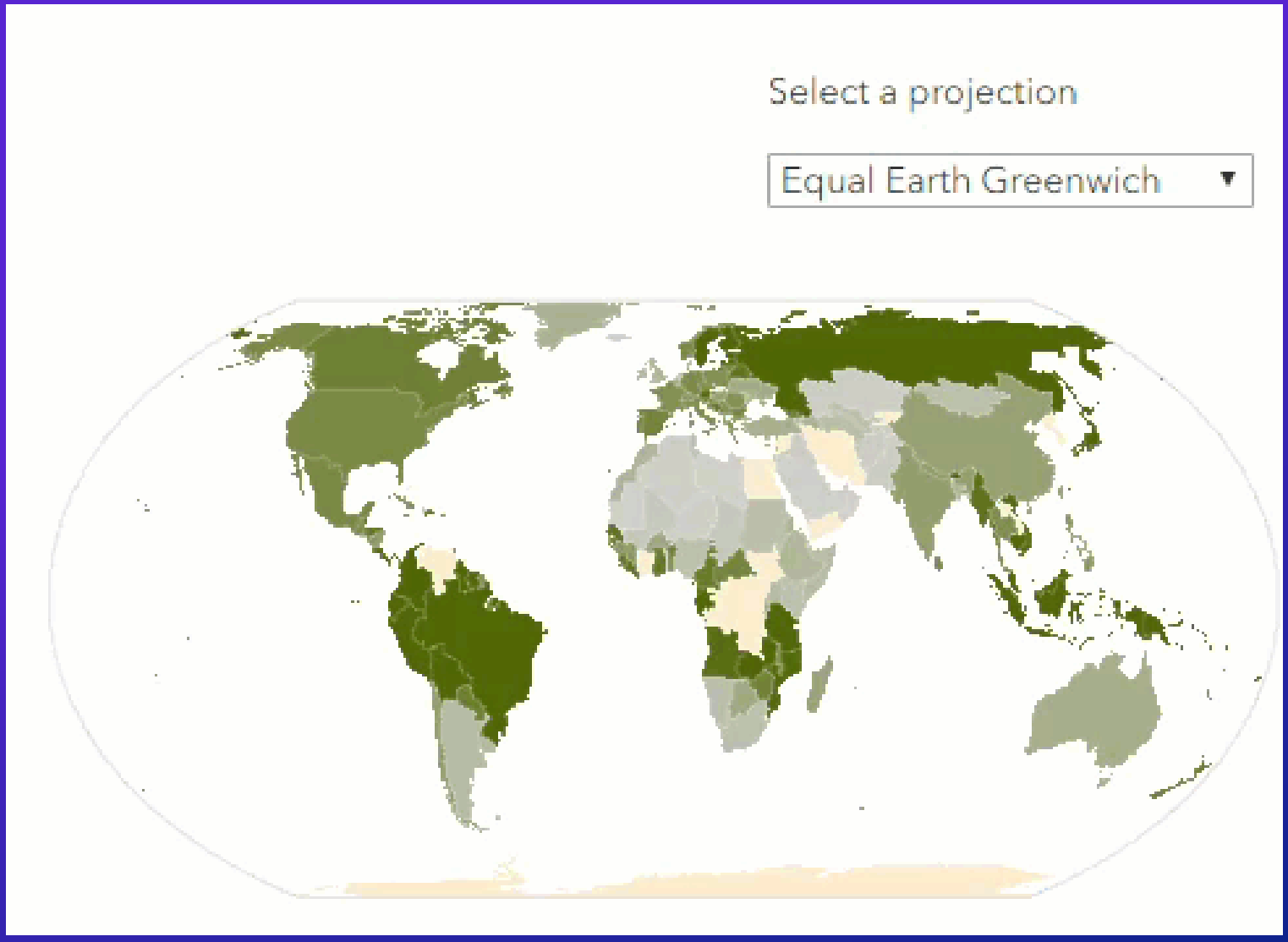
```
const projection = new Projection();

if (!projection.isSupported()) {
  console.error("projection is not supported");
  return;
}

if (projection.isLoaded()) {
  console.log("projection already loaded");
  return;
}

projection.load().then(() => {
  console.log("projection loaded");
});
```

Demonstration - Projection



Geodesic Utils

What is Geodesic Utils?

- Lightweight module for performing geodesic computations
- Some redundancy with GeometryEngine (GE)
  - GU.geodesicAreas() vs. GE.geodesicArea()
  - GU.geodesicDensify() vs. GE.geodesicDensify()
  - GU.geodesicLengths() vs. GE.geodesicLength()
- Works on any supported geographic coordinate system include 70+ non-terrestrial systems (e.g. Mars and Moon)

Geodesic Utils - Example

What is the area of the Bermuda Triangle?

```
const MIAMI    = { lat: 25.775278, lon: -80.208889 };  // Florida
const HAMILTON = { lat: 32.293, lon: -64.782 };        // Bermuda
const SANJUAN  = { lat: 18.406389, lon:  -66.063889 }; // Puerto Rico
const polygon = new Polygon({
  rings: [[
    [MIAMI.lon, MIAMI.lat],
    [HAMILTON.lon, HAMILTON.lat],
    [SANJUAN.lon, SANJUAN.lat],
    [MIAMI.lon, MIAMI.lat]
  ]]
});
const areas = geodesicUtils.geodesicAreas([polygon], "square-kilometers");
const area = Math.round(areas[0]);
console.log(`Area: ${area} km²`); // Area: 1150498 km²
```

Geodesic Utils - Mars Rovers

How far is Curiosity (active) from Opportunity on Mars?

```
const polyline = new Polyline({
  spatialReference: {
    wkid: 104905 // Mars 2000 Coordinate System
  }
});
polyline.addPath([ curiosity.geometry, opportunity.geometry ]);

const distance  = geodesicUtils.geodesicLengths([polyline], "kilometers")[0];
const densified = geodesicUtils.geodesicDensify(polyline, 100);

const path = new Graphic({
  attributes: {
    oid: 1,
    distance
  },
  geometry: densified
});
```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