Using Esri in an Architecture for Real-Time Presentation of Machine Learning Evaluations

ArcGIS Technologies as Microservices

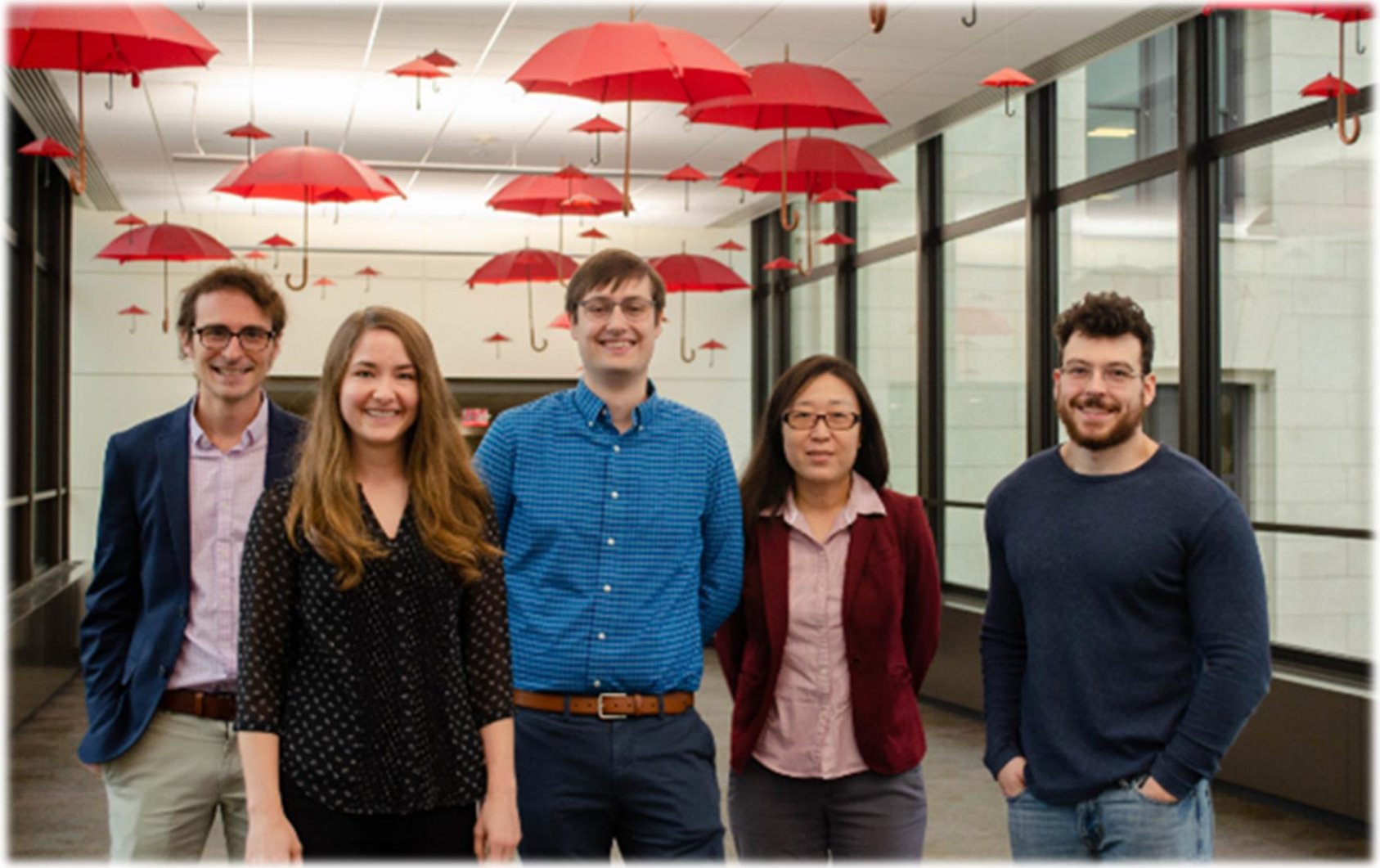
Brad Gawron
Lead Imagery Software Engineer
Travelers Insurance, Artificial Intelligence Accelerator
bgawron@travelers.com

TRAVELERS

©2021 The Travelers Indemnity Company. All rights reserved.

Development Team

The machine learning model discussed in this presentation was developed by a multi-disciplinary team including GIS Developers and Data Scientists



Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Wildfire Total Loss Identification

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2020

©2020 The Travelers Indemnity Company. All rights reserved.

Business Problem

- Leveraging After-Event Imagery from Aerial Imagery Vendors
- Representatives at the National Catastrophe Center evaluate incoming imagery, spending hours to do so
- If a method of prioritization were available, it could guide which properties representatives look at first.

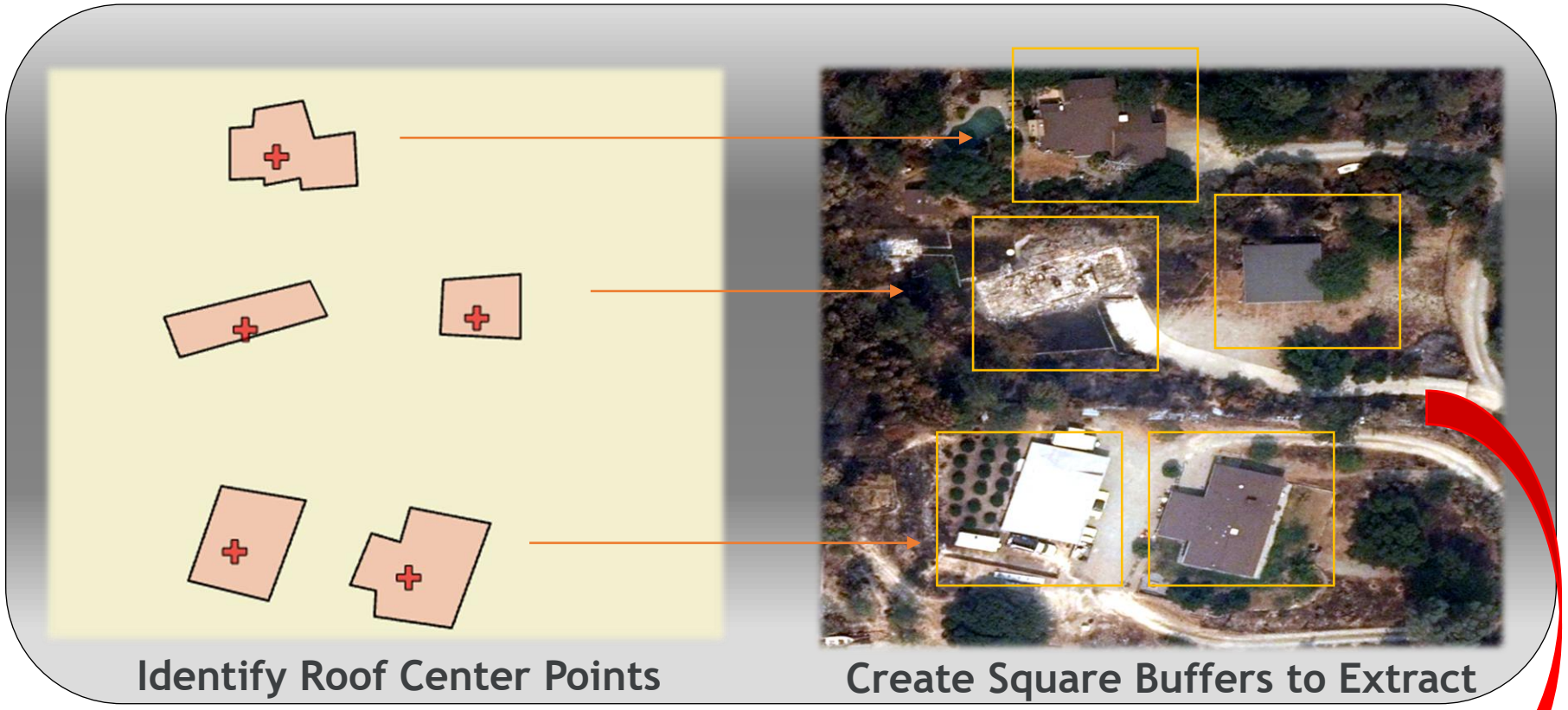
©2021 The Travelers Indemnity Company. All rights reserved.

Development Problem

- Traditional modeling relies on data which is available at known times and in known formats, and with no spatial component
- Not only did the development team need to provide a way to provide user input for the what, the where and the when…
- The business users desired near-real time output from the model

©2021 The Travelers Indemnity Company. All rights reserved.

Garbage In – Garbage Out

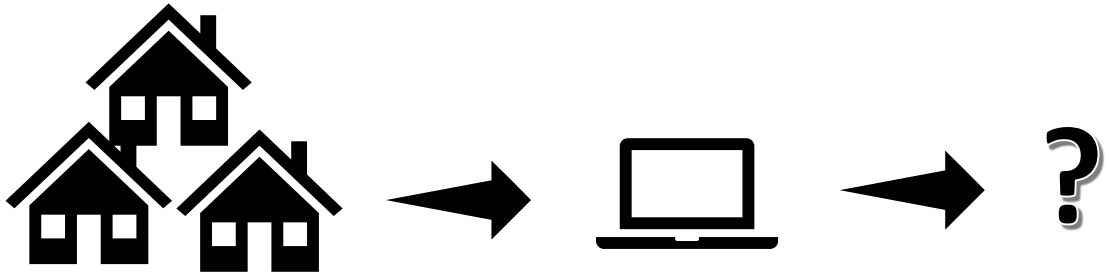


Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021
©2021 The Travelers Indemnity Company. All rights reserved.

Garbage In – Garbage Out

Challenge 1: Produce Adequate Volume of Training Data

Distilling Millions of Footprints Into Centroids

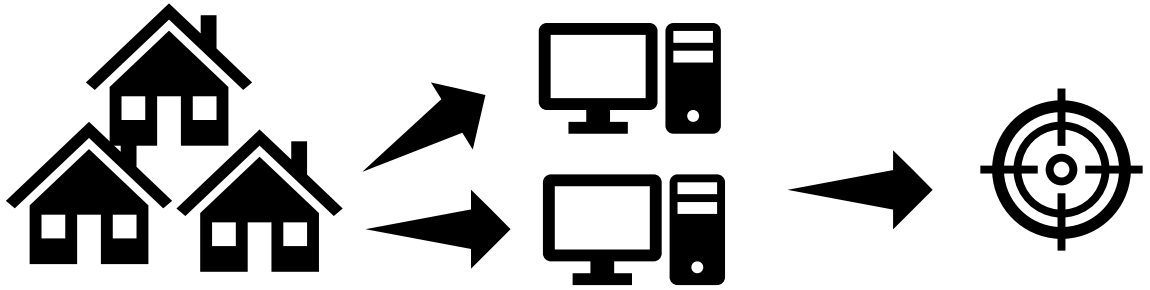


Using a Local Machine with ArcGIS Pro

The Volume of Data is Prohibitively Large

Causes RAM Outage

Crashed a Machine Almost Instantly



Using Esri's `GIS Tools for Hadoop`

User defined functions to bring Spatial Analysis to Distributed Computing

Enables the Demand on Resources to be Spread Across Multiple Machines

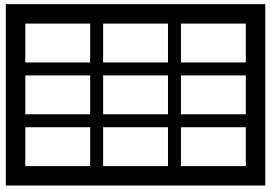
Allowed Six Million Footprints to be Distilled in Seconds.

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Challenge 2: A New Approach to Models -Putting the Parameters in a User's Hands



Traditional Data Science

- Known data availability
- No geographic component
- Can be executed on a predictable time series
- Enables batch and cron jobs

Catastrophe Image Analysis

- Catastrophic fires can happen anytime
- Extent of fire or imagery captured is unknown
- Time to flight/processing time unknown
- Unknown elements build case for a GUI-based approach to model execution

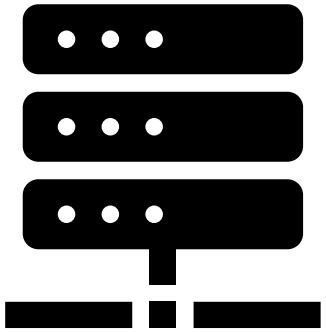
Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

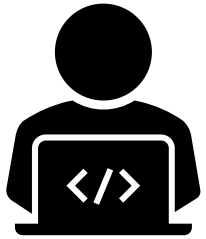
Approaching Fully Within the ArcGIS Enterprise Ecosystem

Create Geoprocessing Service Using ArcGIS Pro and Publish

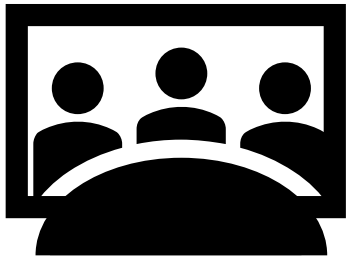


ArcGIS Server

Transmit Jobs to Service and Receive Results via Web Interface (WAB, etc.)



GIS Developer



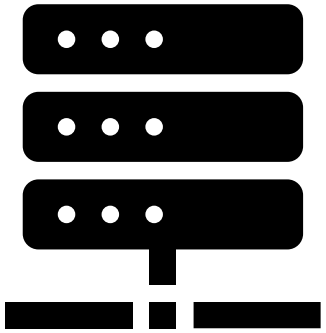
Business Consumers

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Considerations of the ArcGIS Enterprise Full Stack



ArcGIS Server

Benefit

- Out-of-the-Box Stability and Logging
- Rapid Standup, especially with WAB
- Approachable and maintainable for a broad level of coding experience

Tradeoff

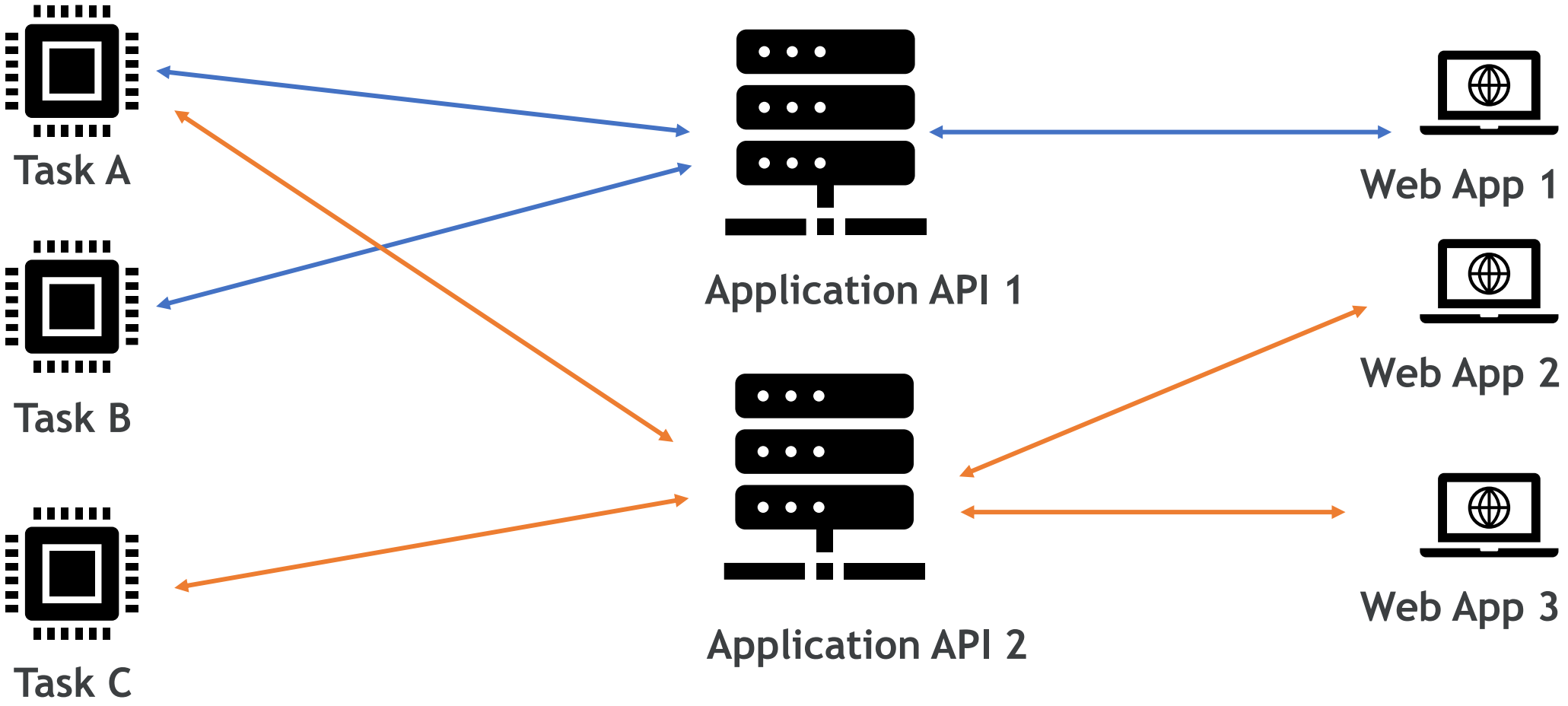
- Interactions with Open Source Python Packages can be Unpredictable
- Complex/Limited Capability to Multithread
- Monolithic Architectures can be Difficult to Reuse in Pieces
- Web App Builder Limits Flexibility on the Front-End

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Microservice Architectures

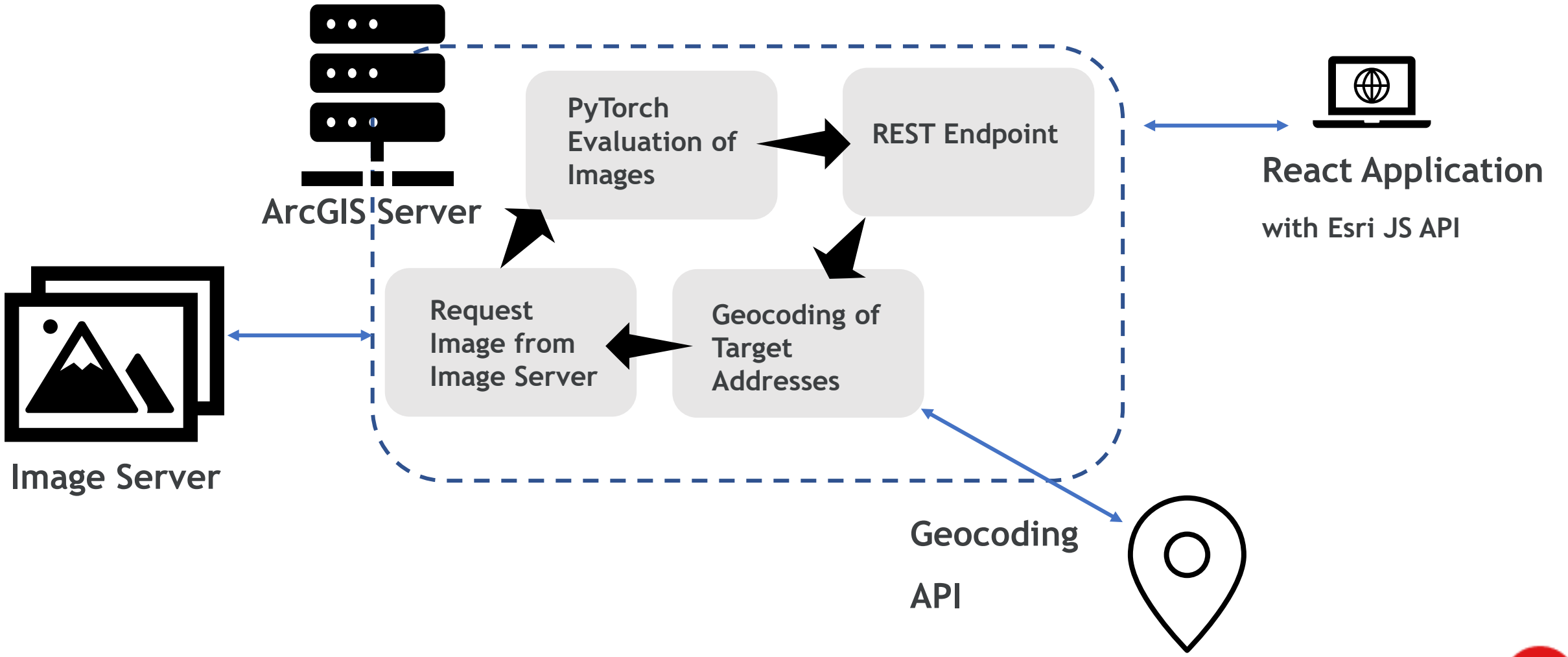


Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Wildfire Model Implementation ArcGIS Monolith

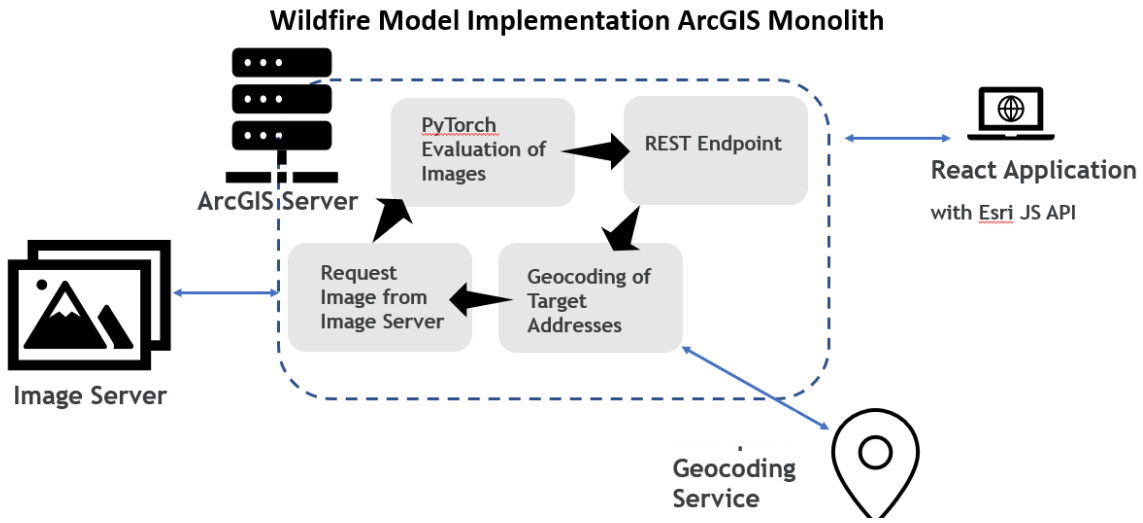


Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Wildfire Model Implementation ArcGIS Monolith



Challenges

- REST Call to Image Server takes 5 sec Average
- Single-thread Execution Blocks Image Download
- Deployment to ArcGIS Pro Version of Server (Torch requires Python3) is tricky if not impossible
- User Result Can Take 10 seconds per Location (360 Per Hour)

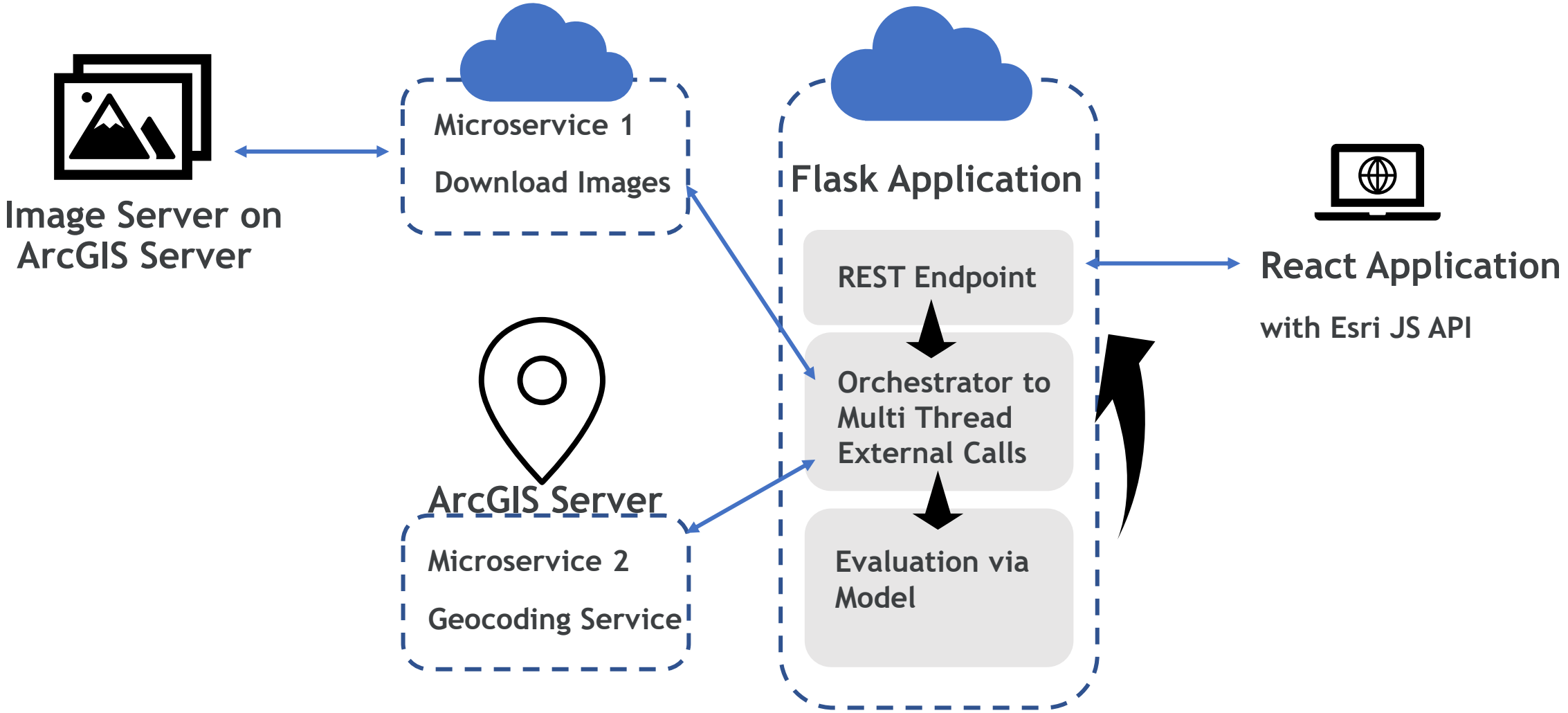
Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

DEVELOPMENT PROBLEM

Real Time is Real Fast

Wildfire Model Implementation ArcGIS Microservices

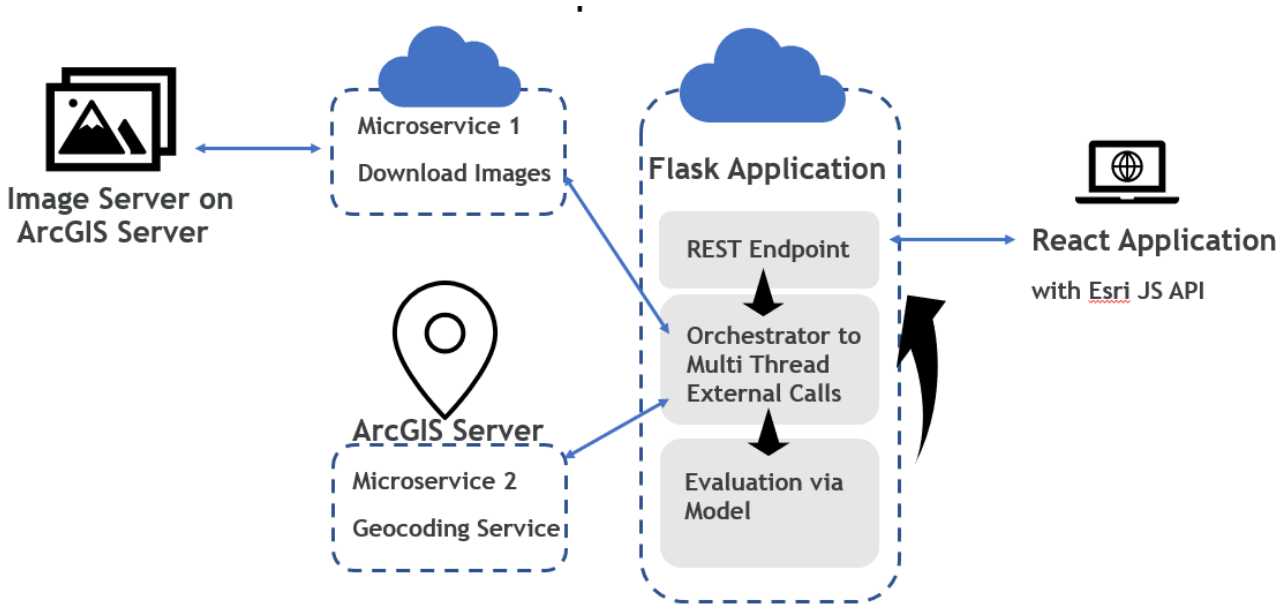


Brad Gawron | bgawron@travelers.com| Esri DevSummit 2020

©2020 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Wildfire Model Implementation ArcGIS Microservices



Benefits

- Threads are Non-Blocking

(Even if 1 Thread takes 30 seconds, the rest continue)

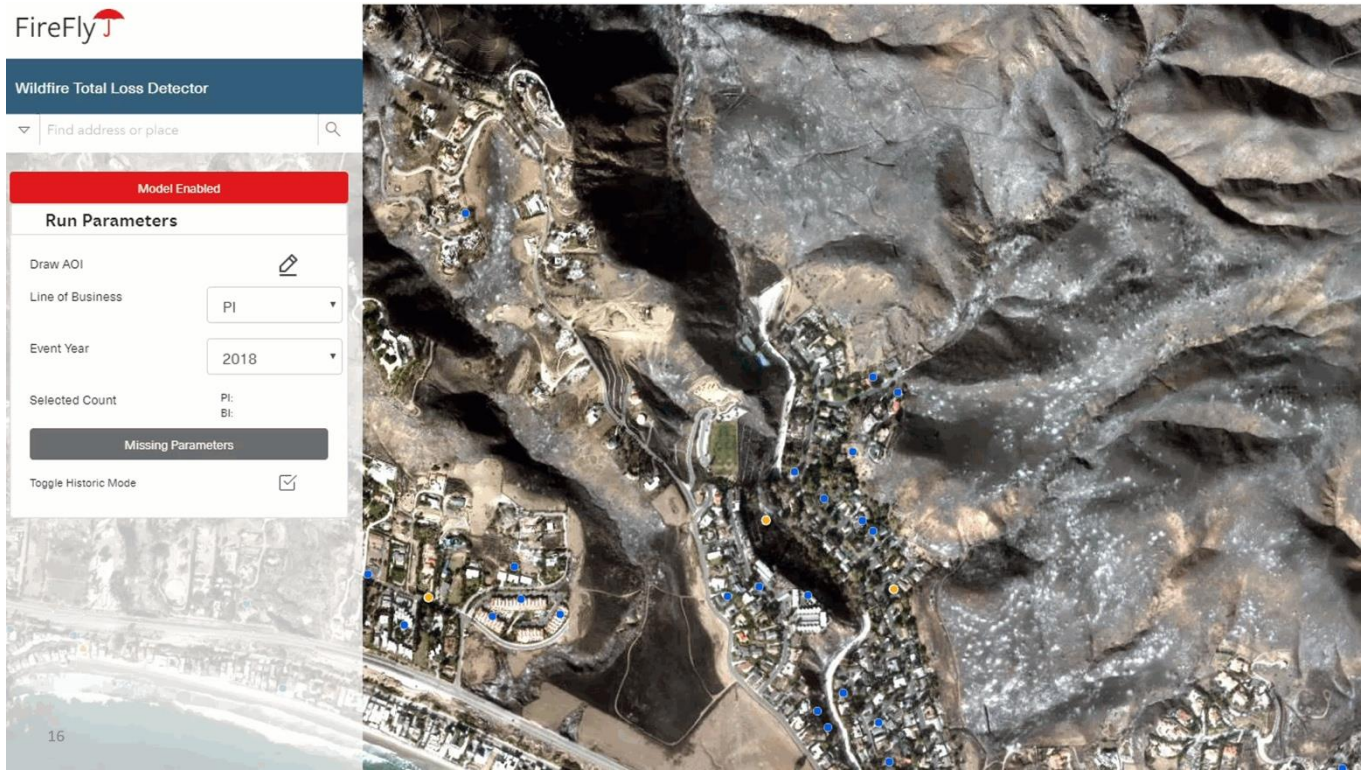
- Ability to reuse image preprocessor in other applications
- Reduction of Average Execution to 1 second per Location

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Putting Execution in the Hands of the User



Basics of the User Interface

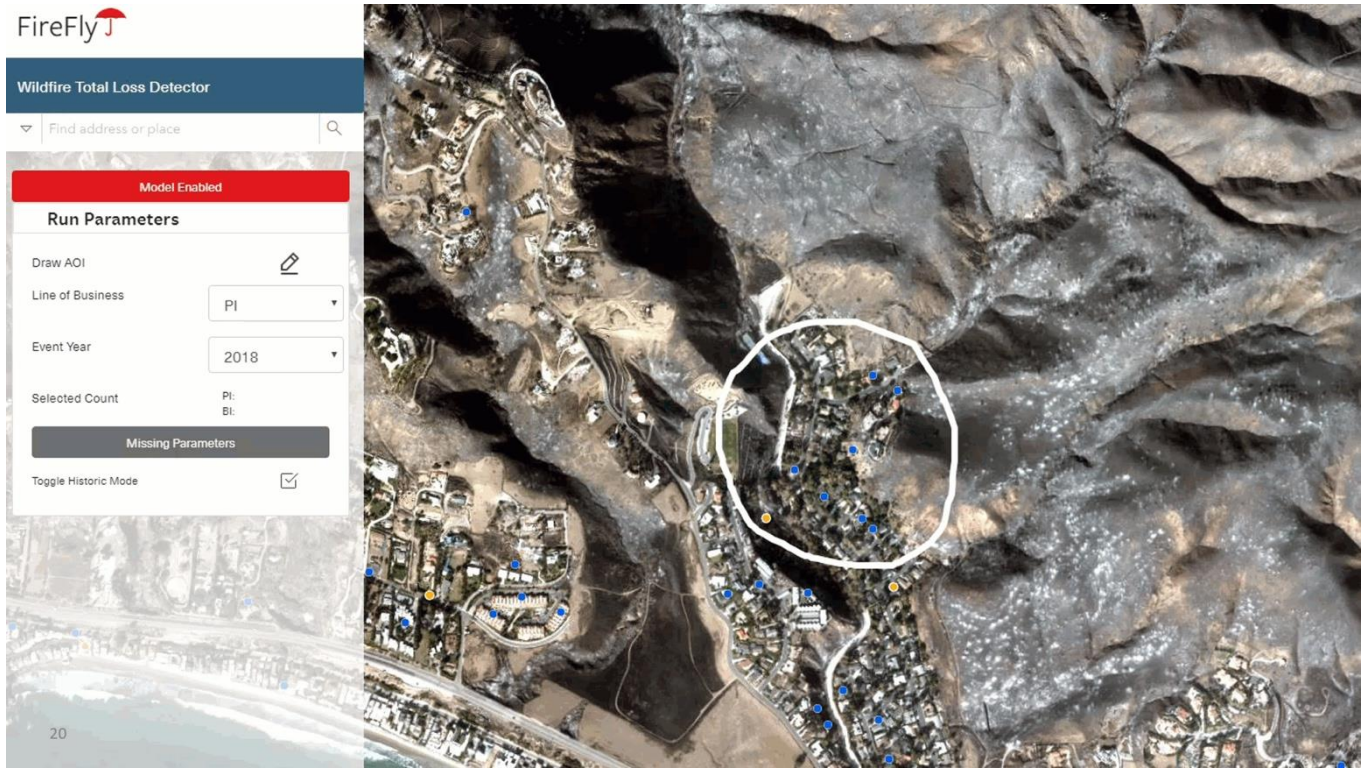
- All user input parameterized in a form which is parsed into JSON
- **ArcGIS API for JavaScript**
  - Search class allows for rapid navigation
  - ImageryLayer class displays allows user to see the imagery the backend interacts with
  - MapImageLayer class allows for rapid display of hundreds of thousands of locations for processing
  - Map and View classes bring these together for the user, and allows for custom interactions

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Putting Execution in the Hands of the User



Drawing the AOI

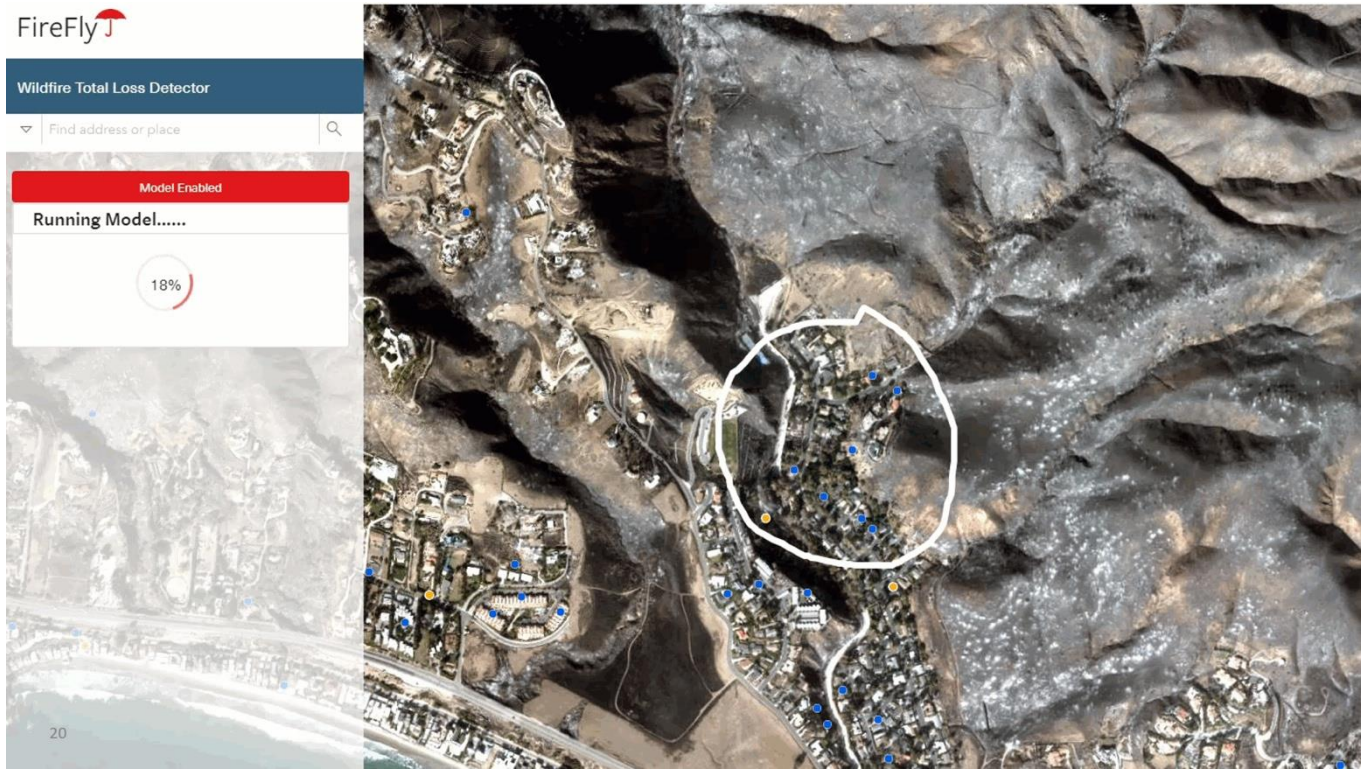
- All user input parameterized in a form which is parsed into JSON
- **ArcGIS API for JavaScript**
  - Draw AOI click event triggers Draw class
  - The user drawing is converted to a Polygon
  - Polygon serves two purposes:
    - Converted to a GraphicsLayer to visualize the area selected
    - Forms the Maximum bounding area which is then transmitted via AJAX to the server

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2020

©2020 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Putting Execution in the Hands of the User



Running the Model

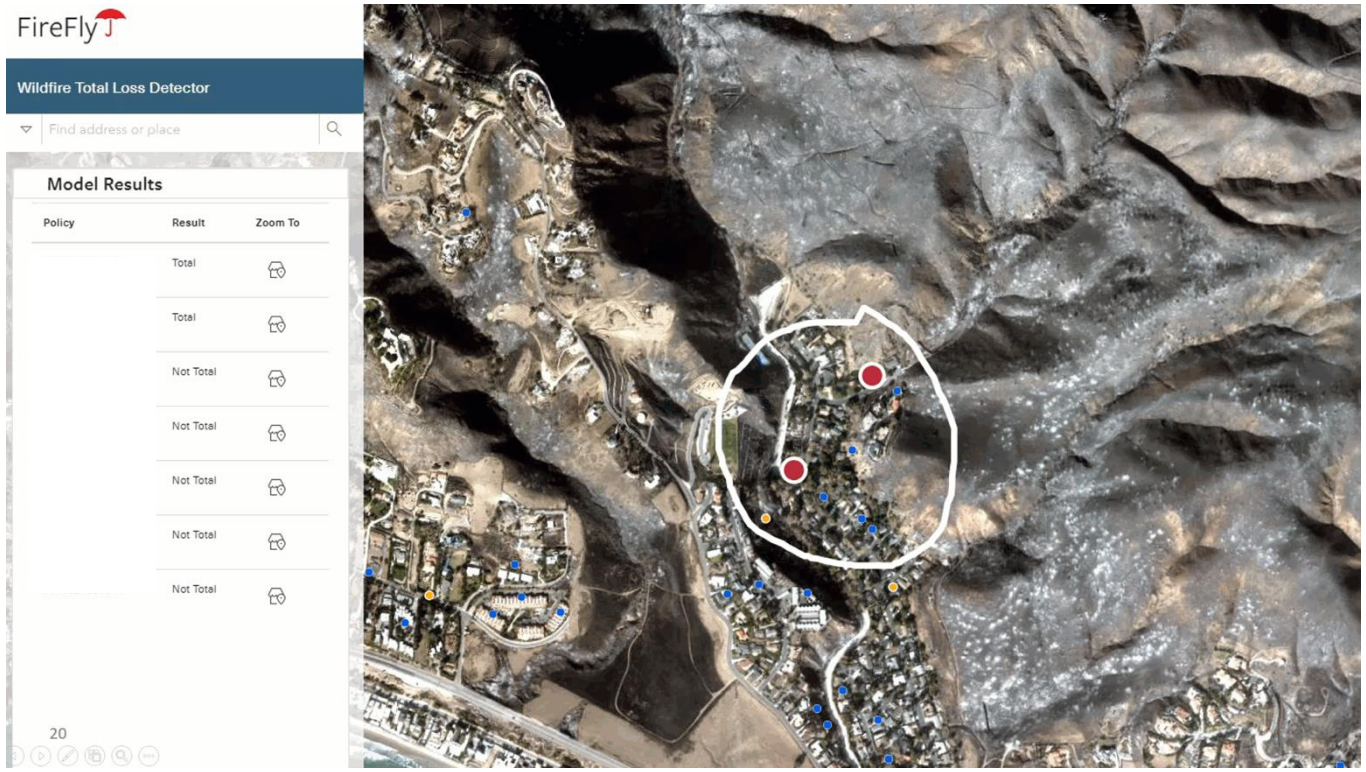
- During this phase no work is occurring on the Frontend, on the Backend however the following is occurring:
  - Imagery for each location downloaded from ImageryService
  - Imagery evaluated using Torch model to identify total losses

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Putting Execution in the Hands of the User



Visualization

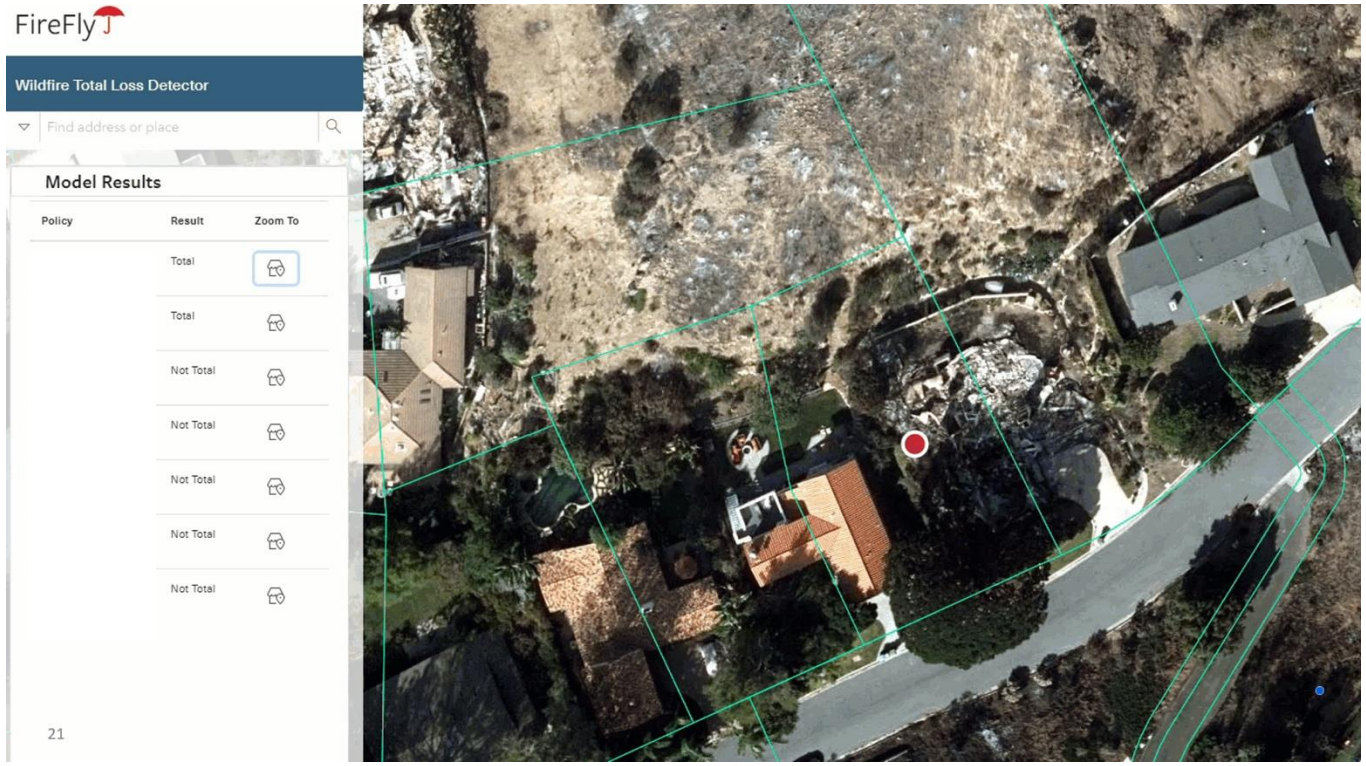
- Server returns its predictions in roughly 1 second per location
- **ArcGIS API for JavaScript**
  - JSON Response From Server Parsed by Client
  - Each Total Loss is added as a Graphic
  - GraphicsLayer is visualized on the map as SimpleMarkers

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

Real Time is Real Fast

Putting Execution in the Hands of the User



Actionable Results

- Locations Sorted by Likelihood of Loss are Displayed
- A Button centering the MapView can target specific locations
- Those locations can be verified by the Catastrophe team

==Faster Identification, Faster Payment

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.

THANK YOU

Questions? Feel free to reach out!
Email or LinkedIn

Brad Gawron | bgawron@travelers.com| Esri DevSummit 2021

©2021 The Travelers Indemnity Company. All rights reserved.