

Heimdall

A Privacy-Respecting Implicit Preference Collection Framework

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We know just the place.

Allow "Yelp" to access your location while you use the app?

This app needs your location to search for nearby businesses.

Don't Allow

Allow

Get Started!

Already have a Yelp account?

Log In

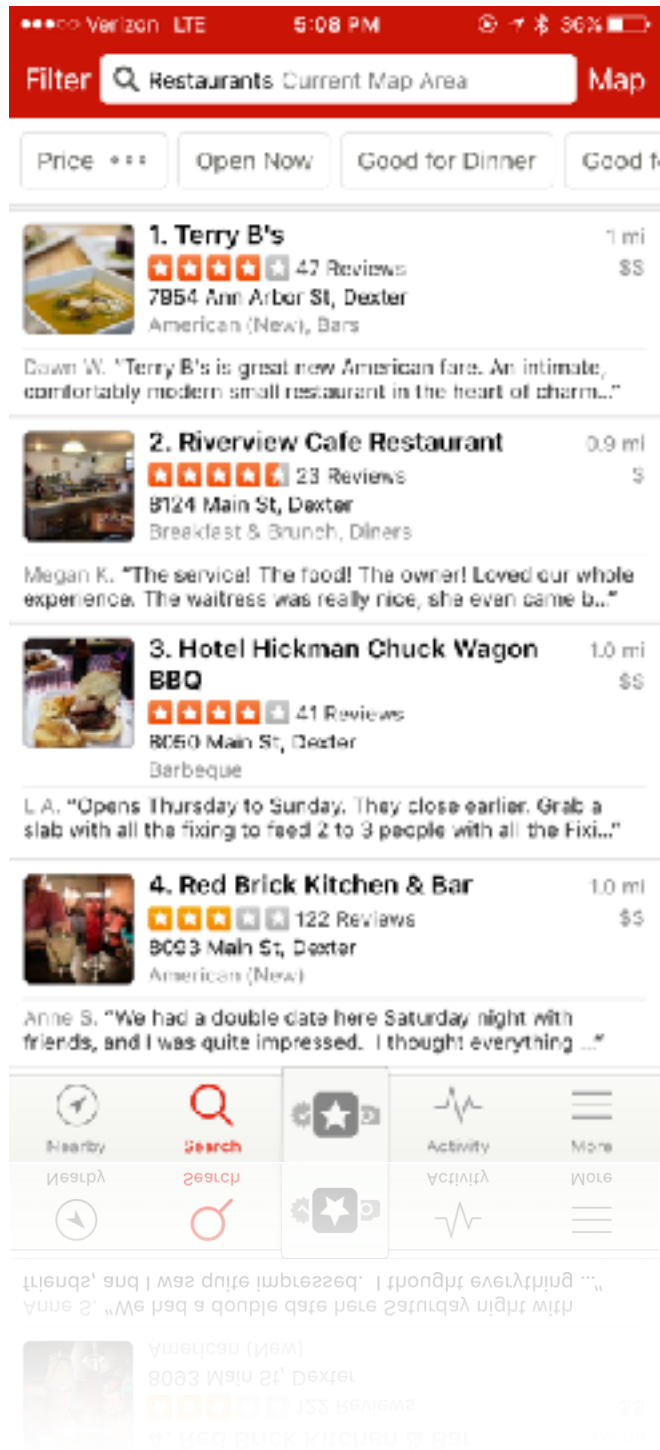
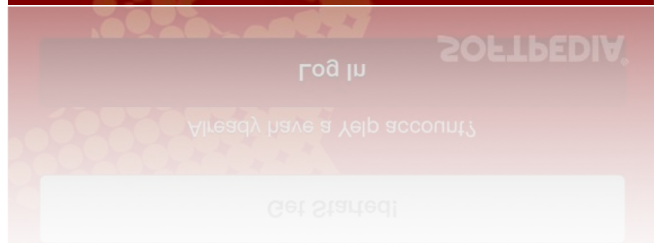
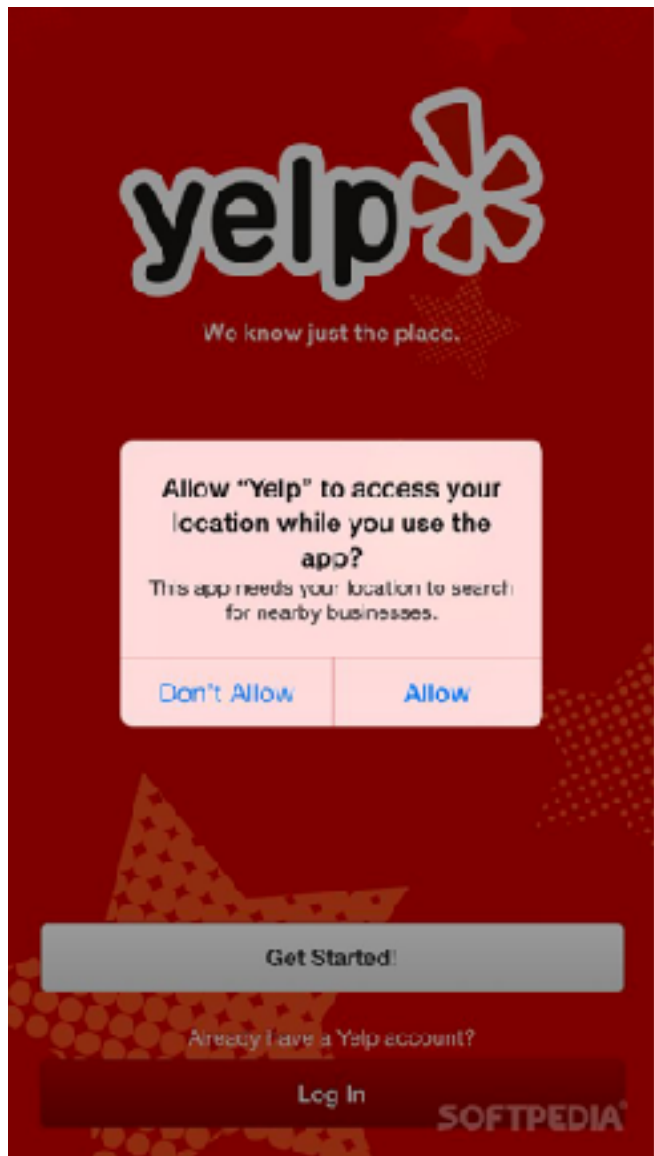
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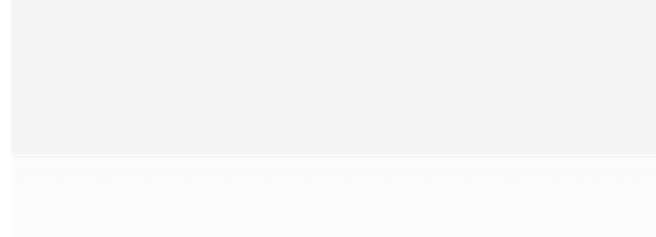
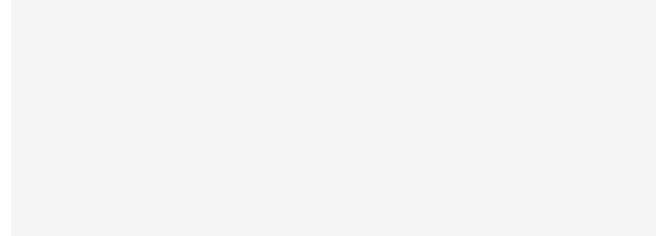
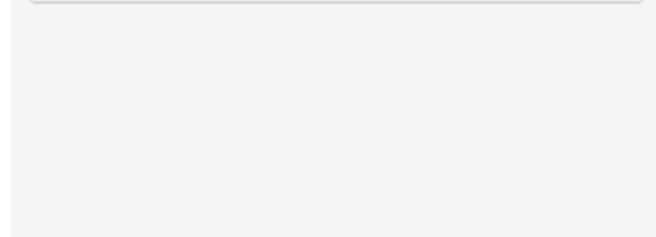
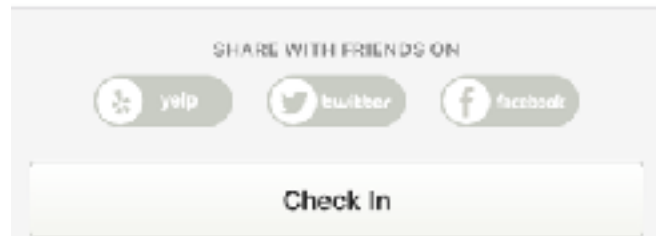
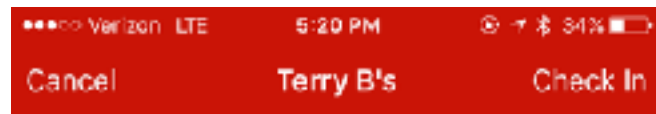
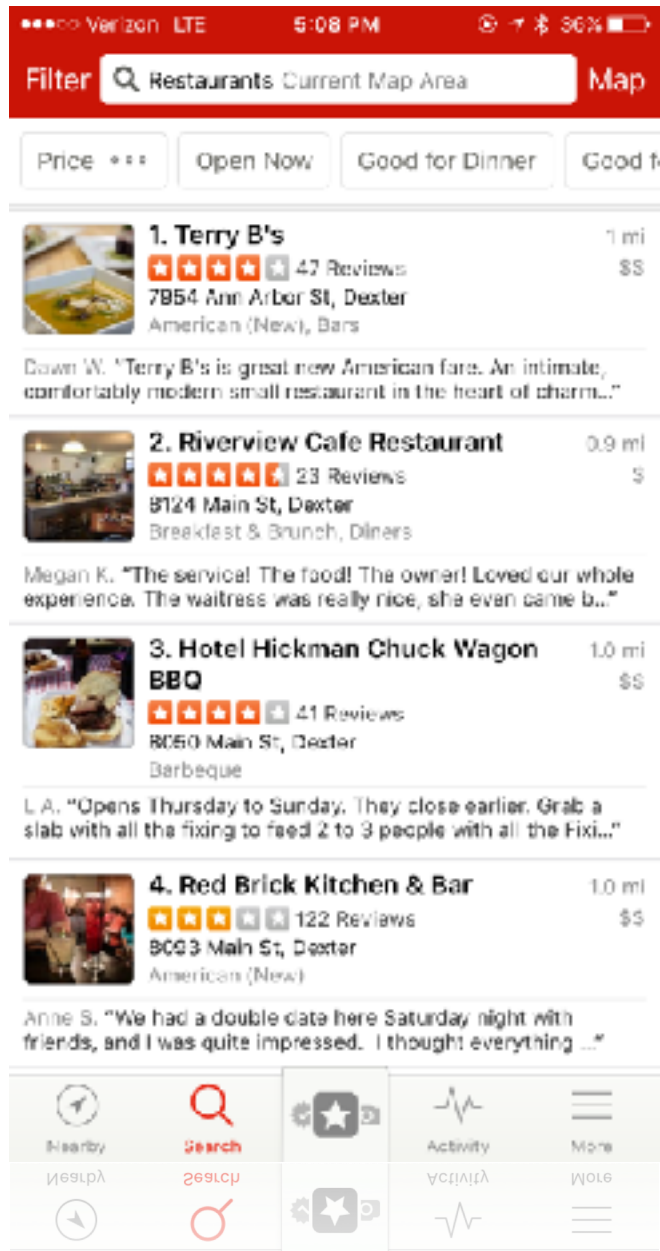
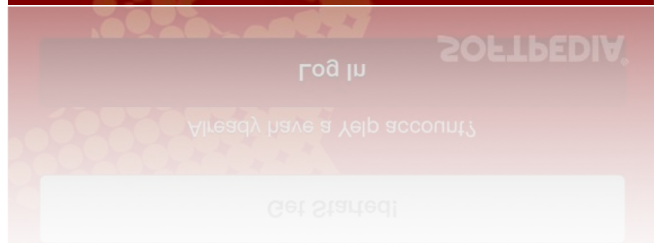
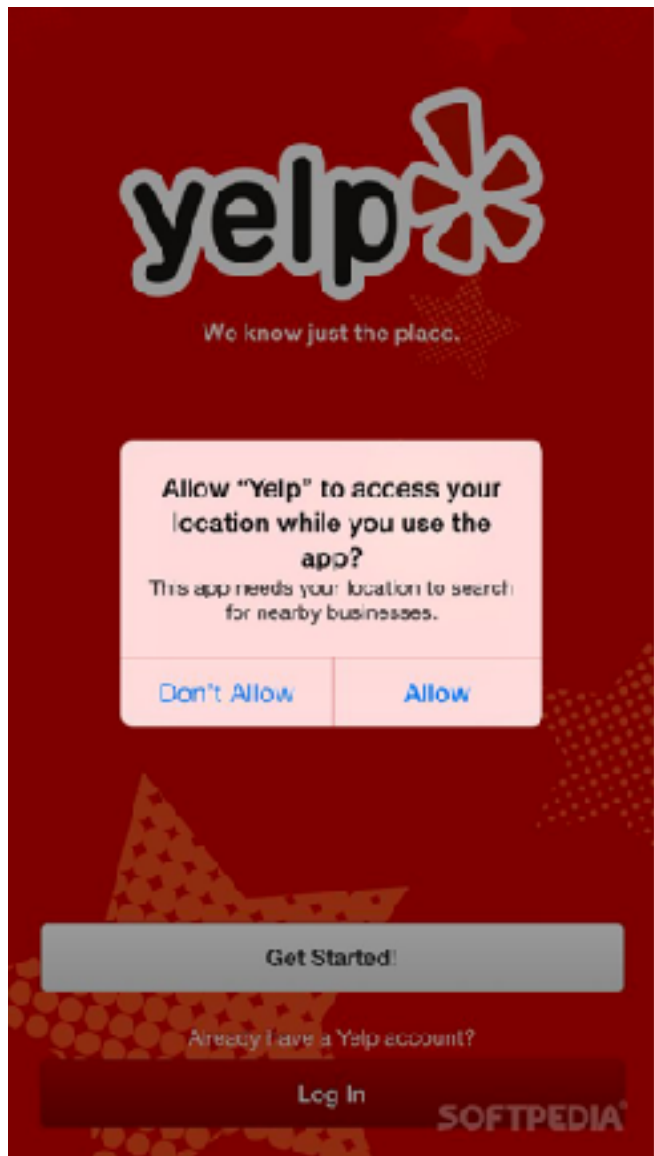
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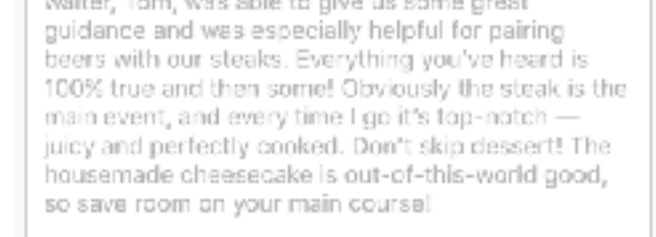
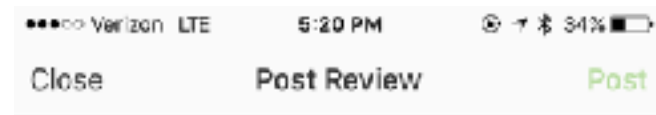
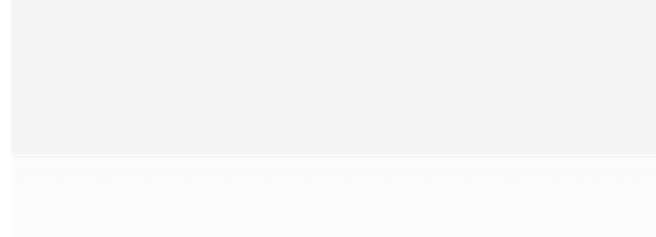
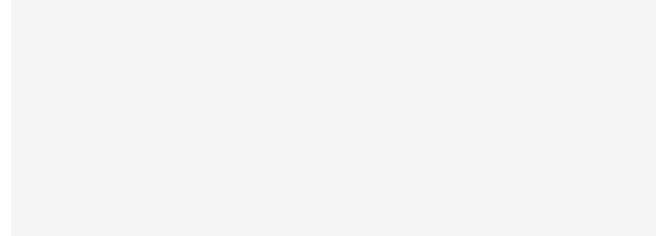
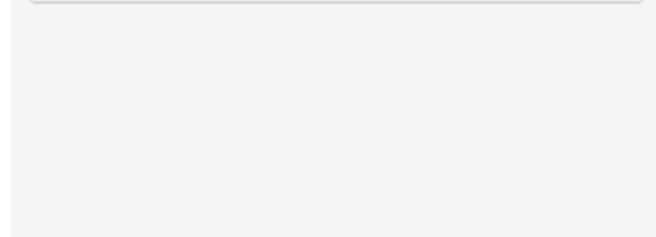
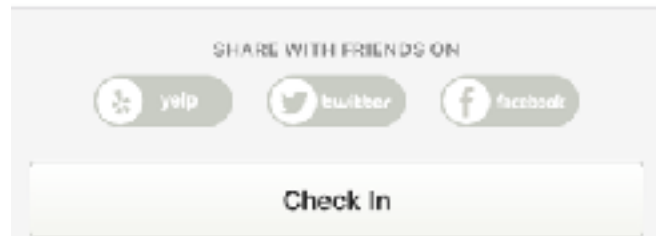
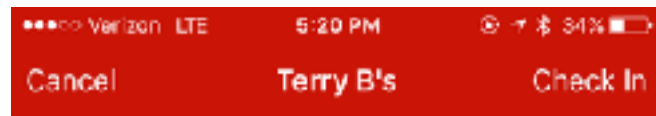
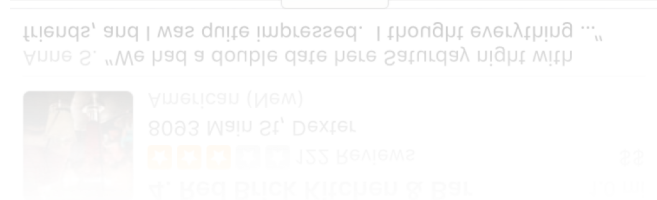
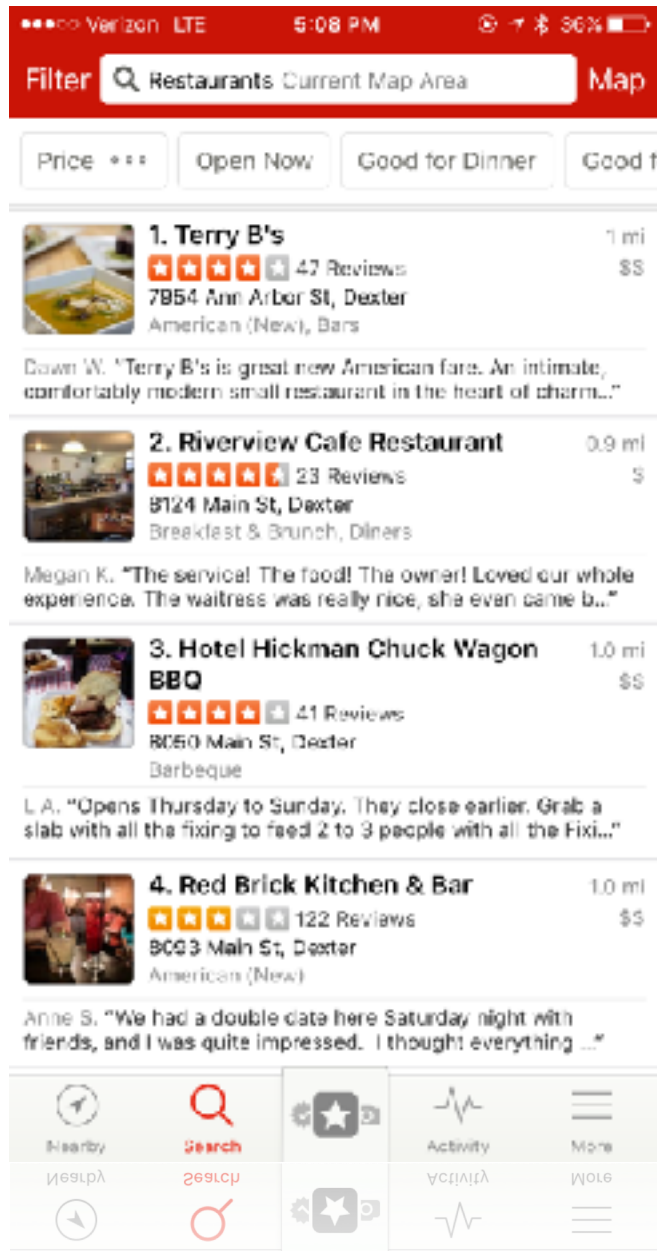
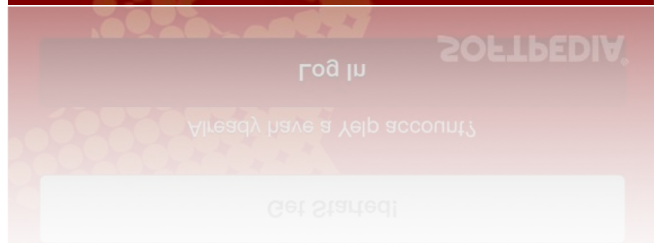
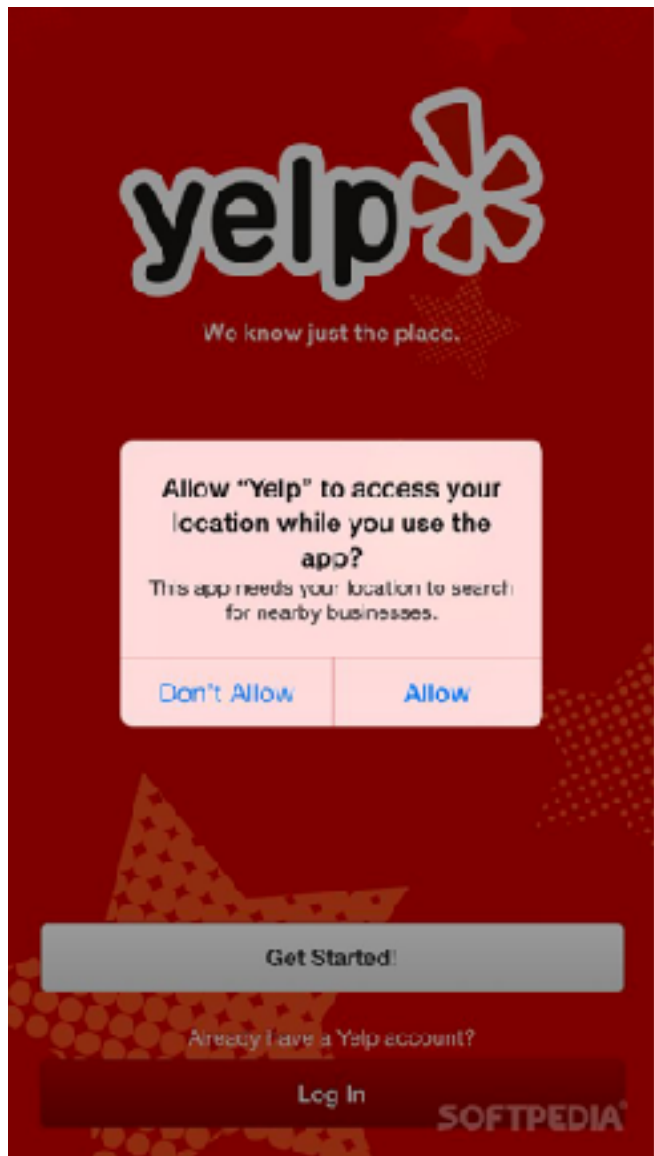
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Verizon LTE 5:08 PM 36%

Filter Restaurants Current Map Area Map



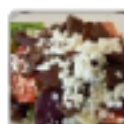

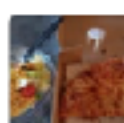
Price *** Open Now Good for Dinner Good for

- 
1. Terry B's 1 mi
 47 Reviews
 7954 Ann Arbor St, Dexter
 American (New)
 Dawn W. "Terry B's is great new American fare. An intimate, comfortably modern small restaurant in the heart of charm..."
- 
2. River View Cafe Restaurant 0.9 mi
 23 Reviews
 8124 Main St, Dexter
 Breakfast & Brunch
 Megan K. "The service! The food! The owner! Loved our whole experience. The waitress was really nice, she even came b..."
- 
3. Hotel Hickman Truck Wagon BBQ 1.0 mi
 41 Reviews
 8050 Main St, Dexter
 Barbeque
 L.A. "Opens Thursday to Sunday. They close earlier. Grab a slab with all the fixing to feed 2 to 3 people with all the fixi..."
- 
4. Red Brick Kitchen & Bar 1.0 mi
 122 Reviews
 8093 Main St, Dexter
 American (New)
 Anne S. "We had a double date here Saturday night with friends, and I was quite impressed. I thought everything ..."

Nearby Search Activity More

Verizon LTE 5:09 PM 36%

Filter Restaurants Current Map Area Map

- 
12. Mugs & Bopps 1.3 mi
 3 Reviews
 2940 Baker Rd, Dexter
 Pizza, Convenience Store, Car Wash
 B.B. "I go here alot and the reason I can rate 5 stars is because there is such great prices on stuff here and so many option..."
- 
13. Classic Pizza 0.9 mi
 13 Reviews
 8015 Huron St, Ste A, Dexter
 Pizza
 Order Pickup or Delivery
- 
14. Alpha Coney Island 2 mi
 14 Reviews
 7049 Dexter Ann Arbor Rd, Dexter
 American (Traditional), Greek
 Al M. "Stopped in to grab a quick breakfast after bicycling on the new Dexter bike trail on a sunny Saturday morning and..."
- 
15. Cottage Inn Pizza 0.9 mi
 14 Reviews
 3219 Broad St, Ste 1, Dexter
 Pizza
 Karen N. "Rude on the phone. Almost hung up but I want my pizza. This guy is not loving his job and it shows"
- 
16. Jet's Pizza 2 mi
 4 Reviews
 7011 Dexter Ann Arbor Rd, Dexter
 Pizza
 bixzer "this guy is not loving his job and it shows..."

Nearby Search Activity More

State of the Art

State of the Art

- Rely on User Interaction and Feedback
 - Interaction Requirement
 - Data Sparsity

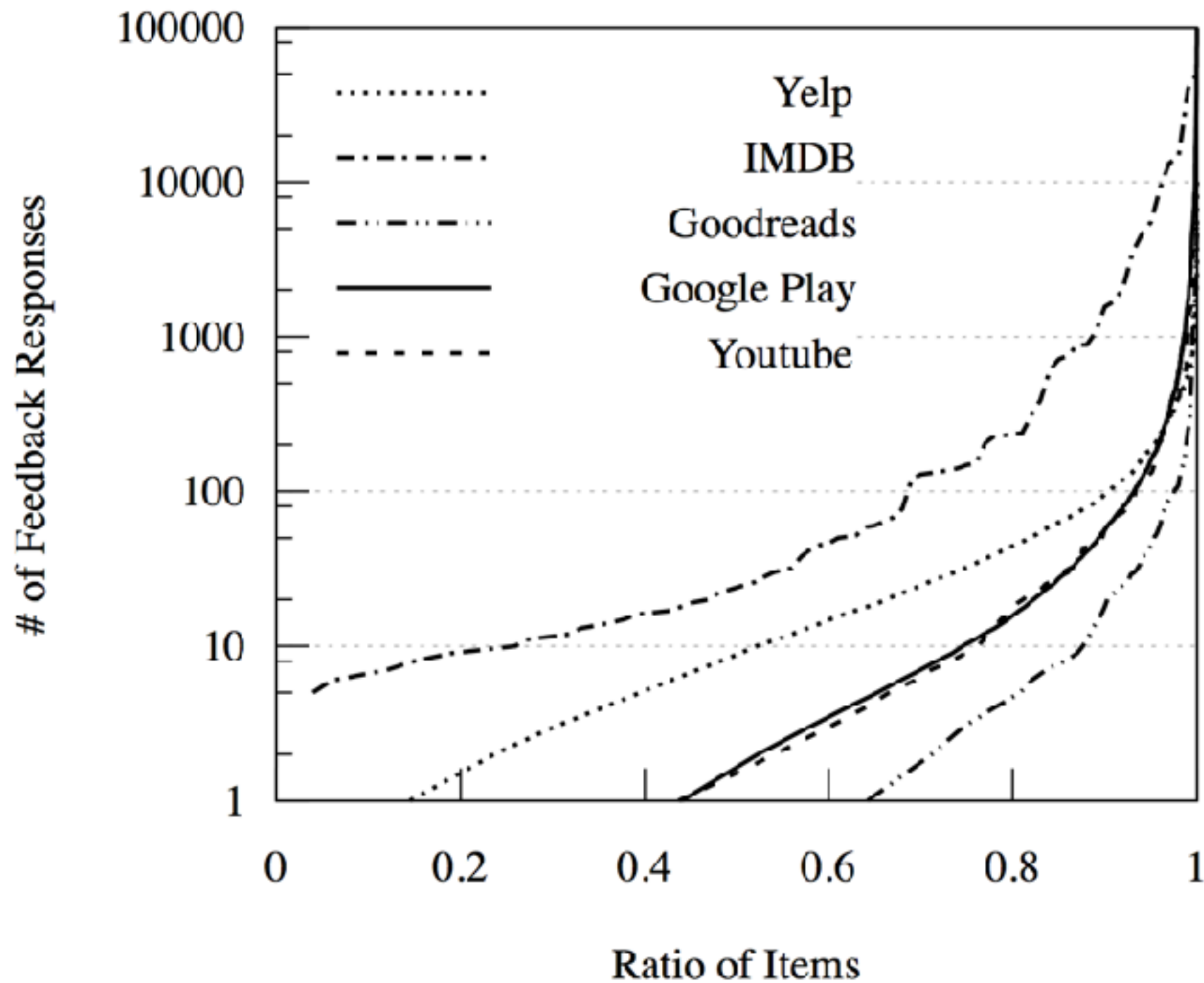
State of the Art

- Rely on User Interaction and Feedback
 - Interaction Requirement
 - Data Sparsity
- Coarse-grained Collection
 - Privacy Concerns

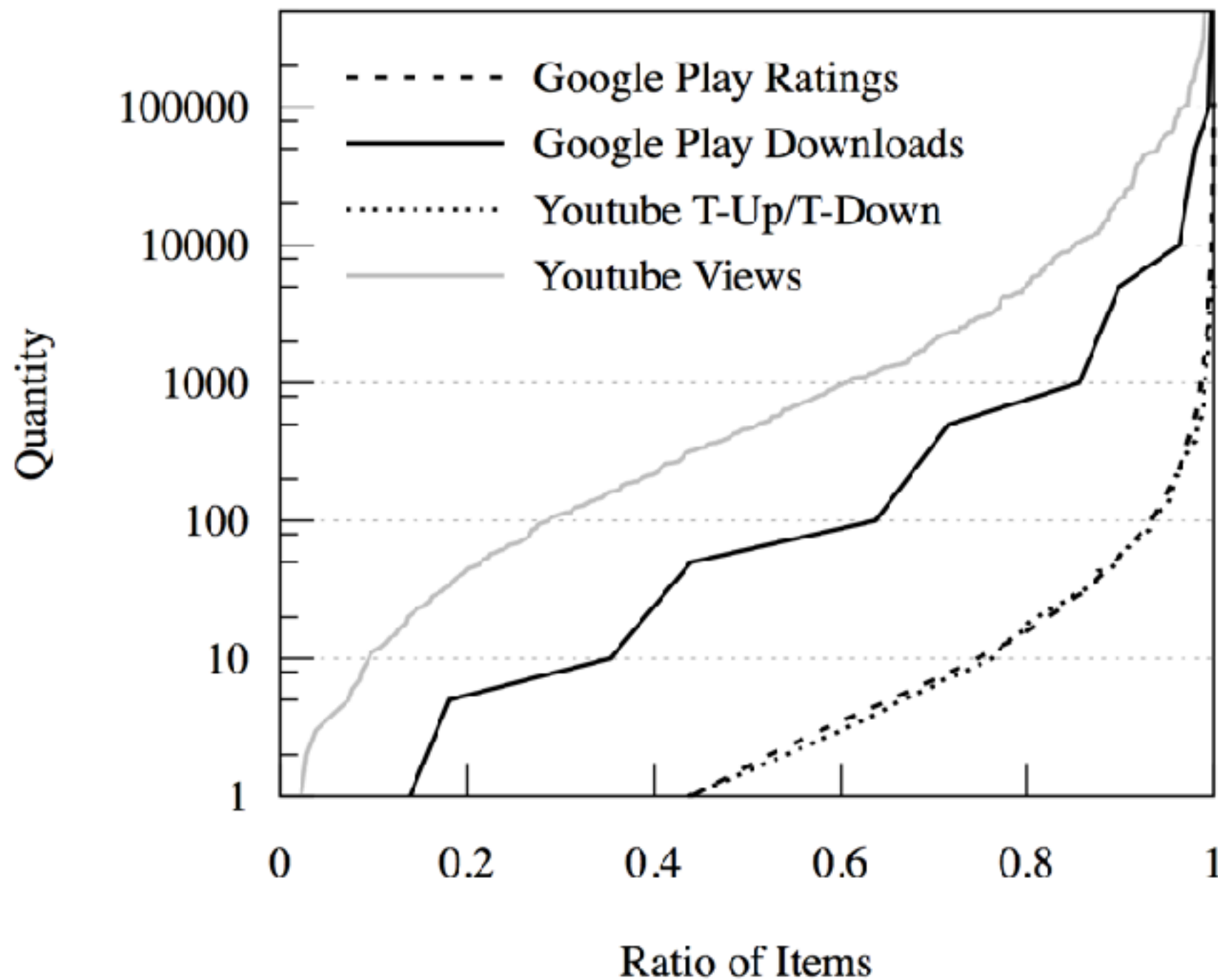
Measurement Study

Source	Type	# of Samples	Definition of Interaction
Goodreads	Books	500	Rating (1-5 stars)
Yelp	Restaurants	10,000	Rating (1-5 stars)
Google Play	Applications	10,000	Rating (1-5 stars)
IMDB	Movies	500	Rating (0.5-5 stars)
Youtube	Videos	500	Up/down vote

Data Sparsity



Discrepancy Between Utilization and Feedback



Allow Privacy-Respecting
Fine-Grained Data Collection

You are allowed to collect the
location...

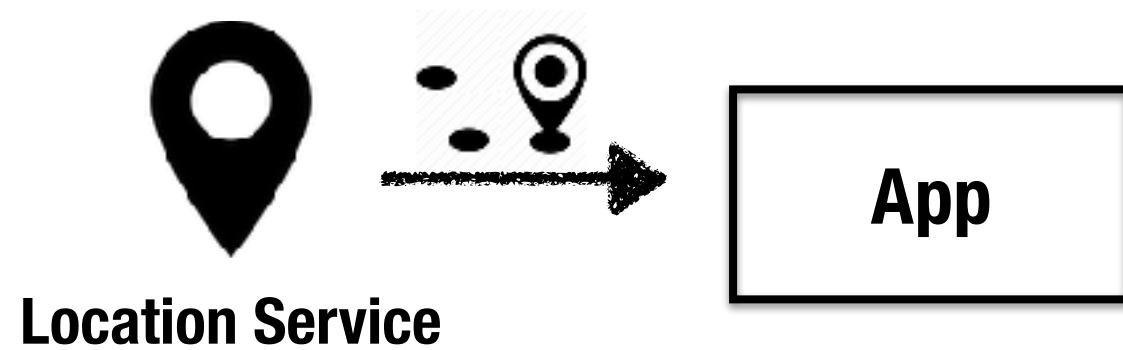
You are allowed to collect the
location... IF the location is a
restaurant.

Restaurant Collector



App

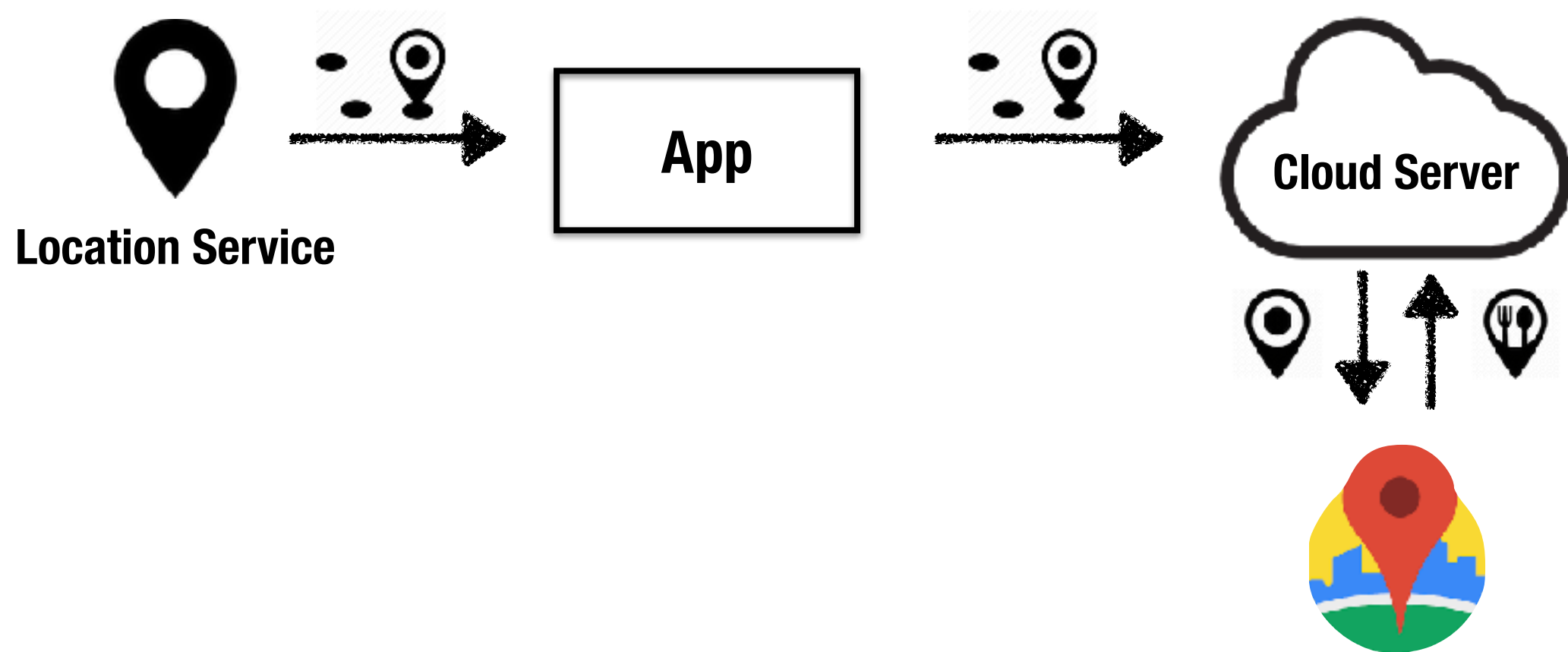
Restaurant Collector



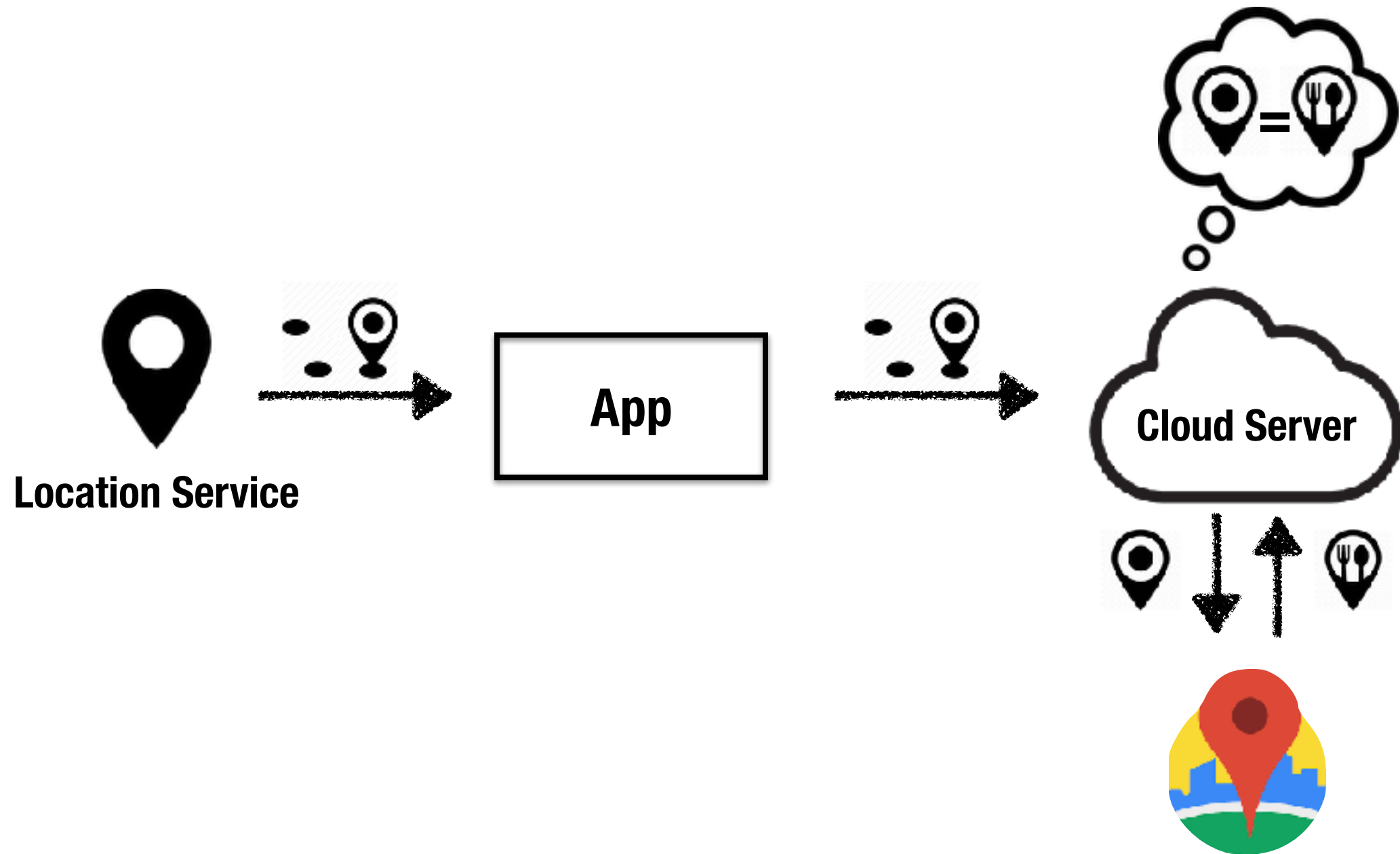
Restaurant Collector



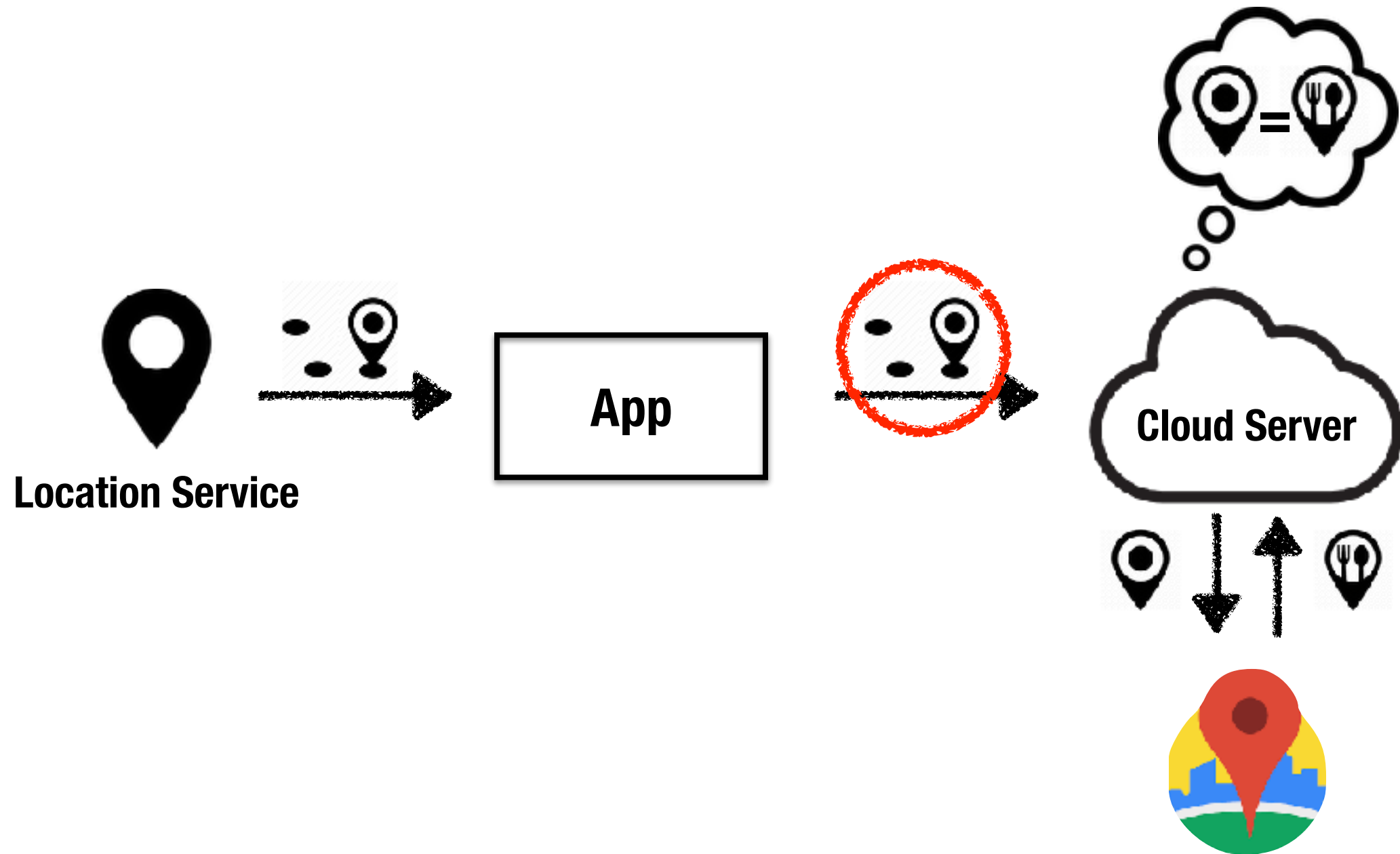
Restaurant Collector



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Restaurant Collector

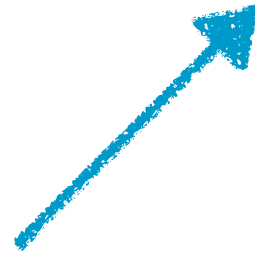


Immutable Blobs

<JSON Data, Path, Signature>

Immutable Blobs

<JSON Data, Path, Signature>



```
"Location"  
{  
  "lat": 40.7155809802915,  
  "lng": -73.9599399197085,  
  "time": "2012-04-23T18:25:43.511Z"  
}
```

```
"googleapis:place"  
{  
  "results": [  
    { "name": "Subway",  
      "types": ["restaurant"],  
      ...  
    },  
    ...  
  ]  
}
```


Immutable Blobs

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googleapis:place:
results:types

Immutable Blobs

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JSON Data
SHA256 HMAC

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googleapis:place:
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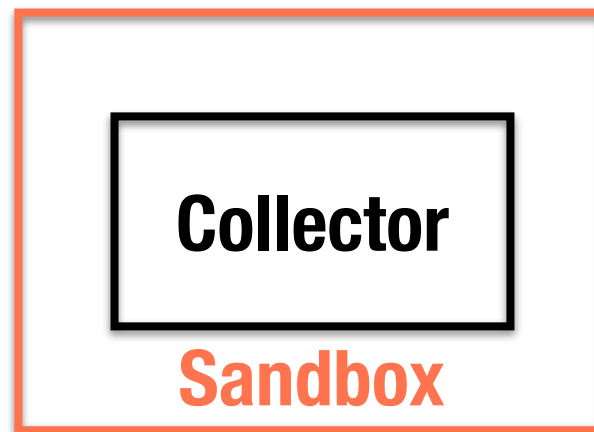
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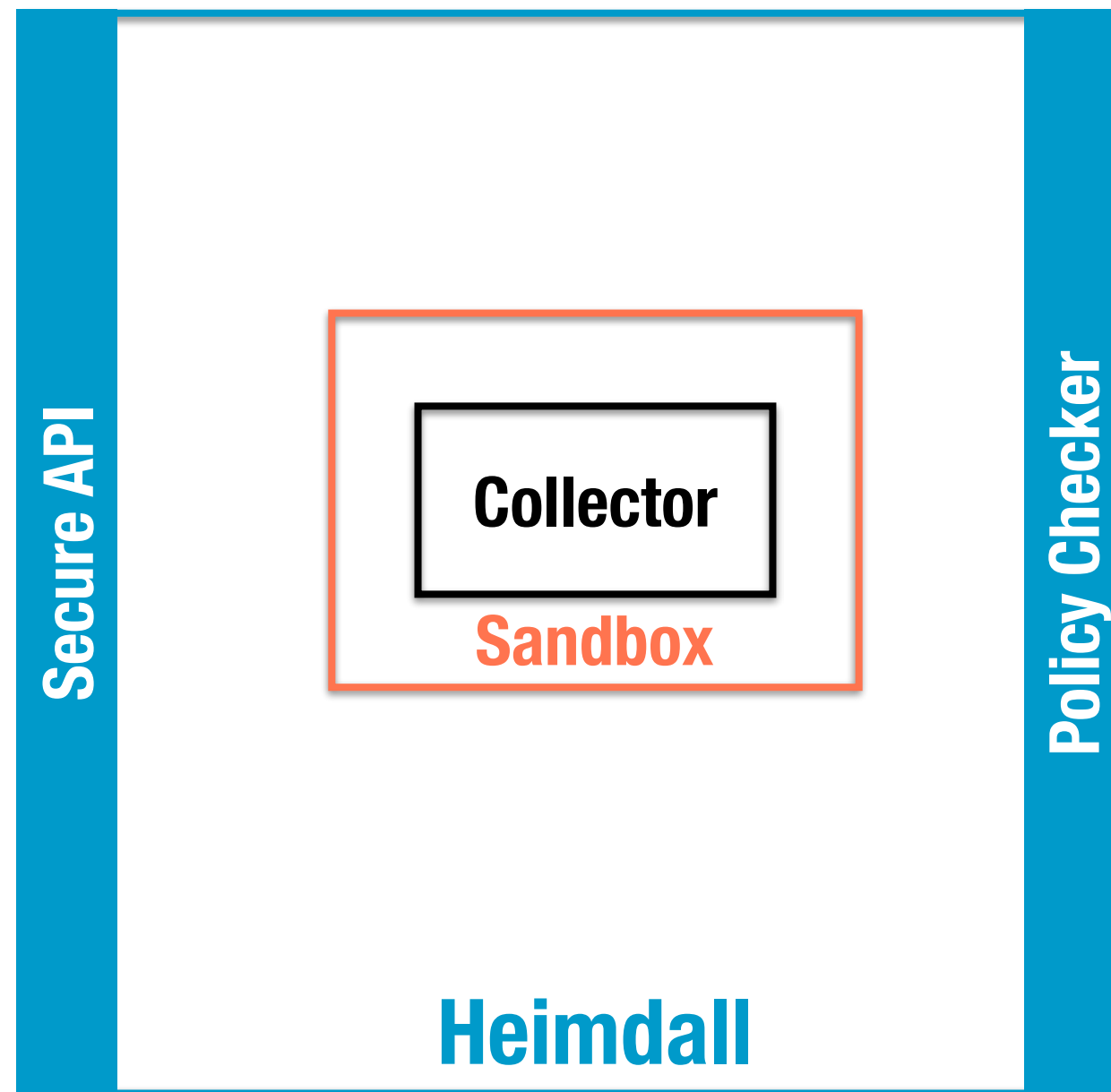
Collector

 Immutable Blob: <JSON Data, Path, Signature>

Restaurant Collector

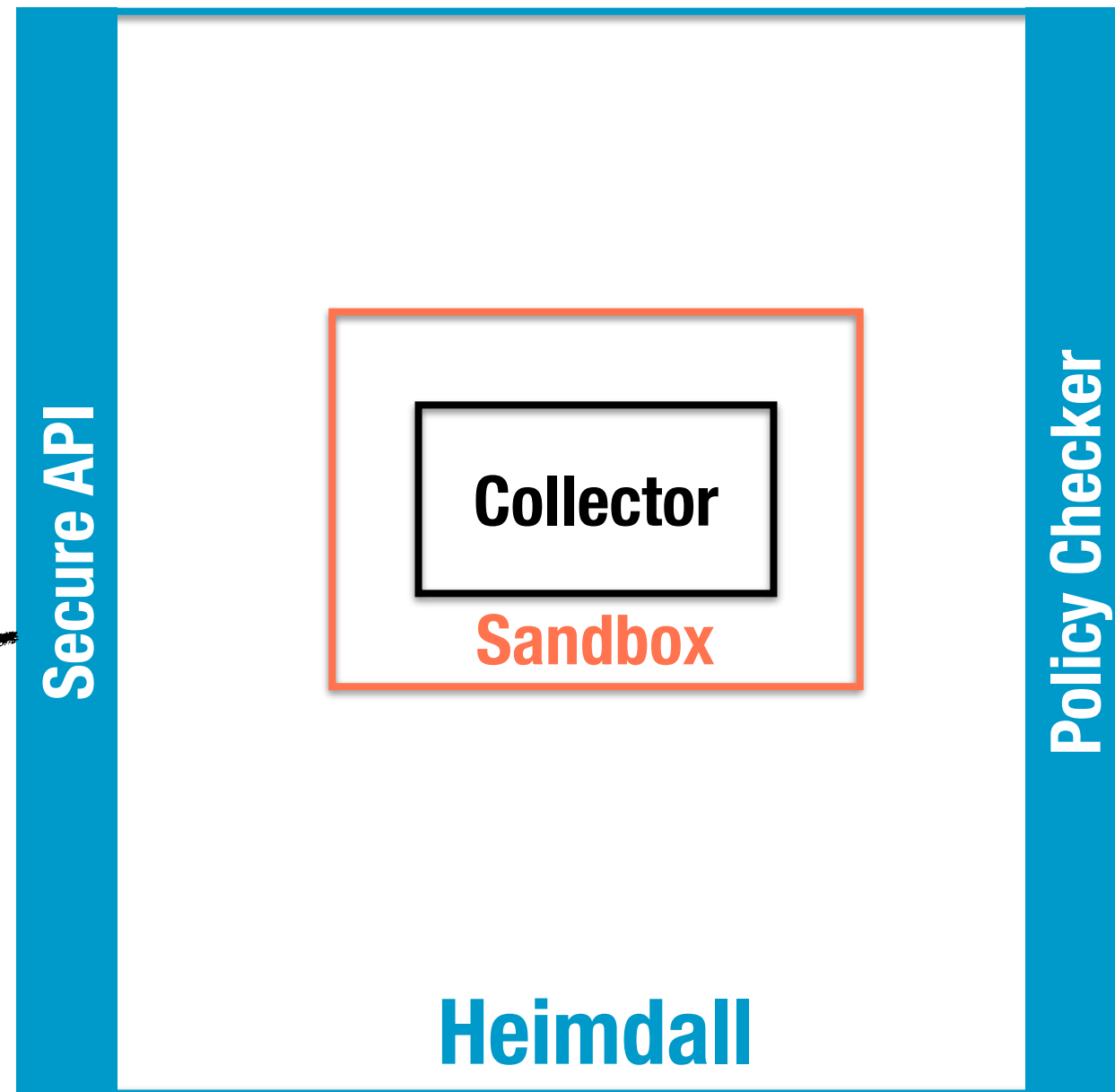


Restaurant Collector



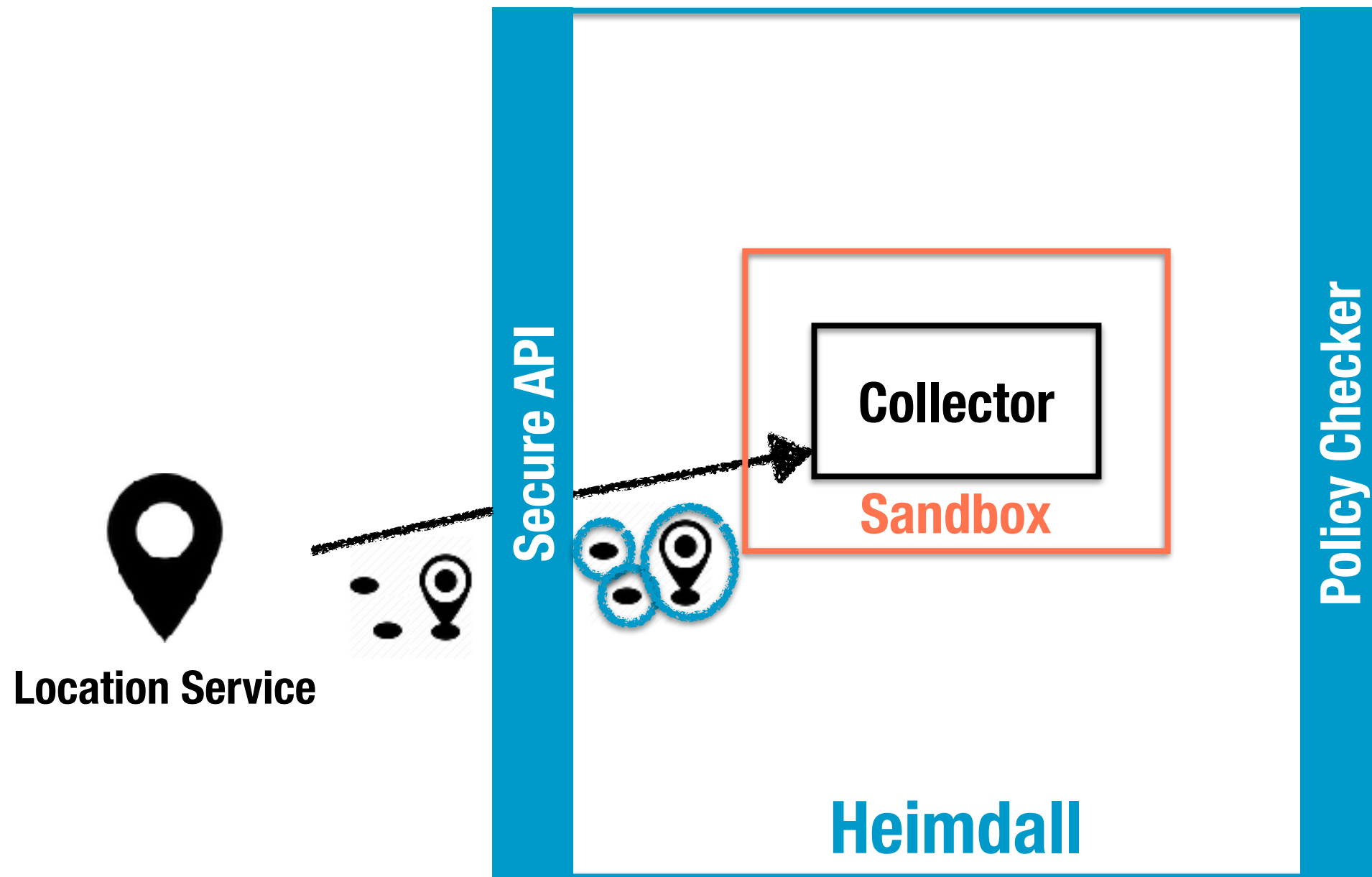
 Immutable Blob: <JSON Data, Path, Signature>

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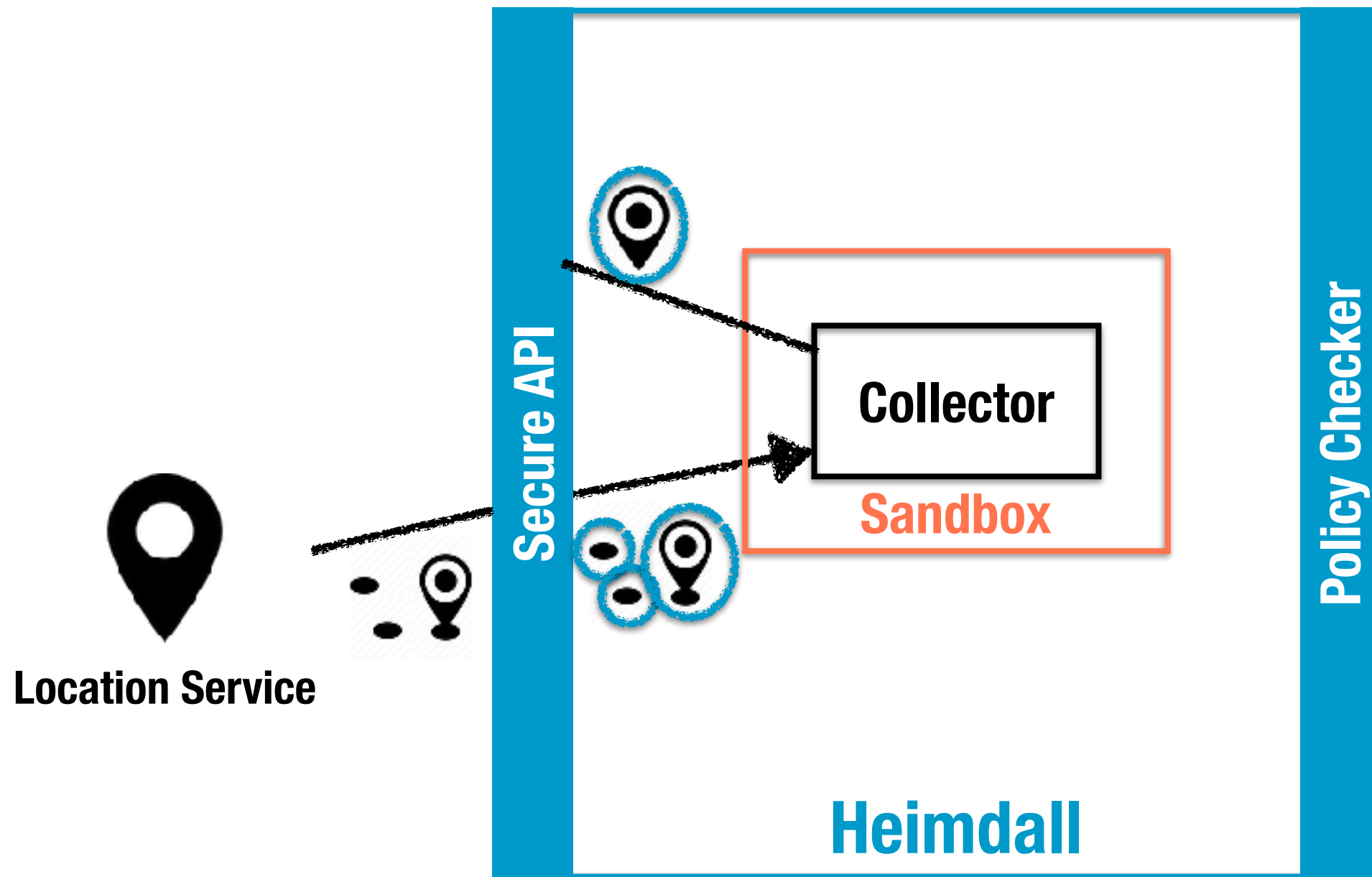
 **Immutable Blob: <JSON Data, Path, Signature>**

Restaurant Collector



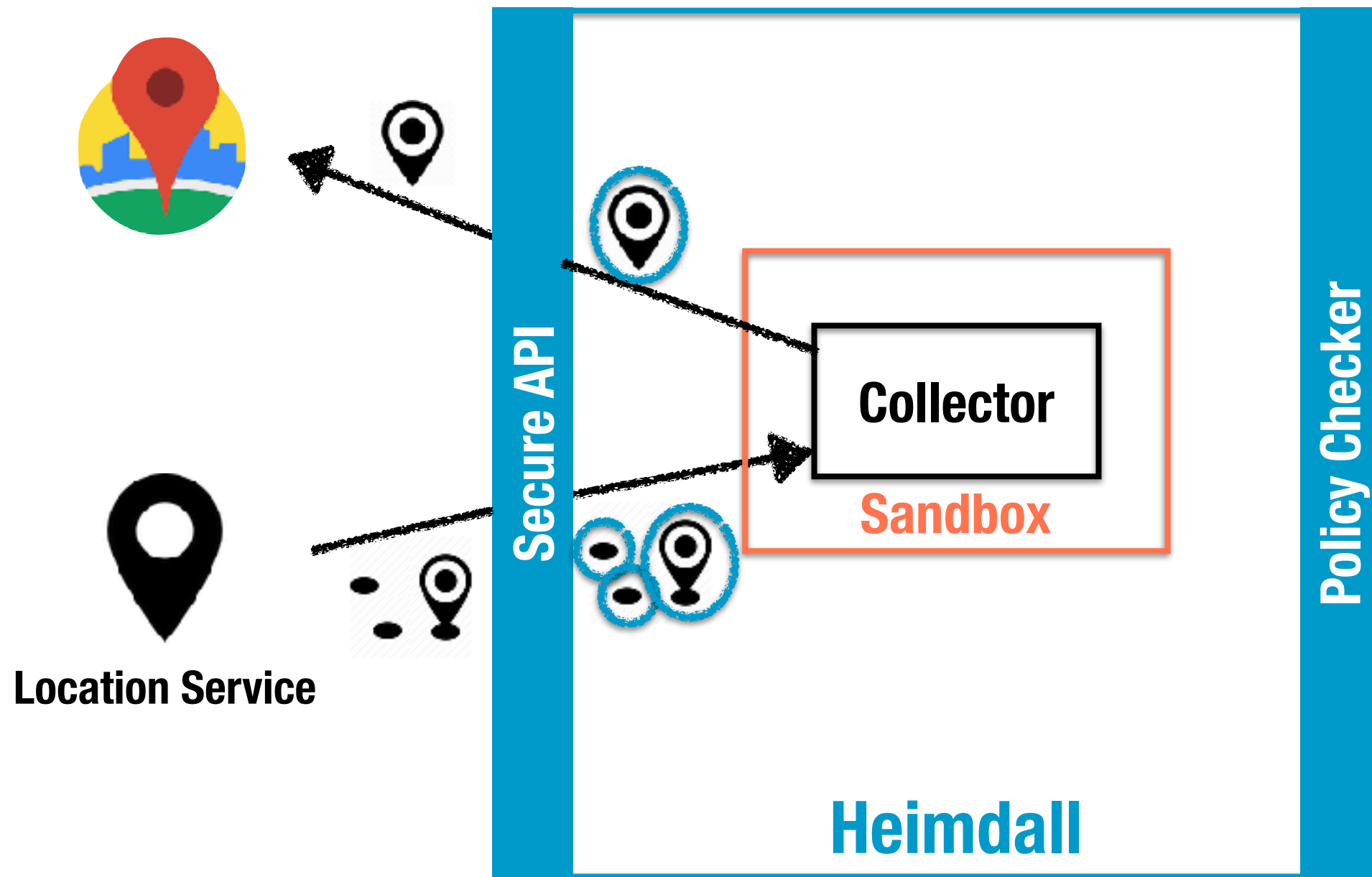
 **Immutable Blob: <JSON Data, Path, Signature>**

Restaurant Collector



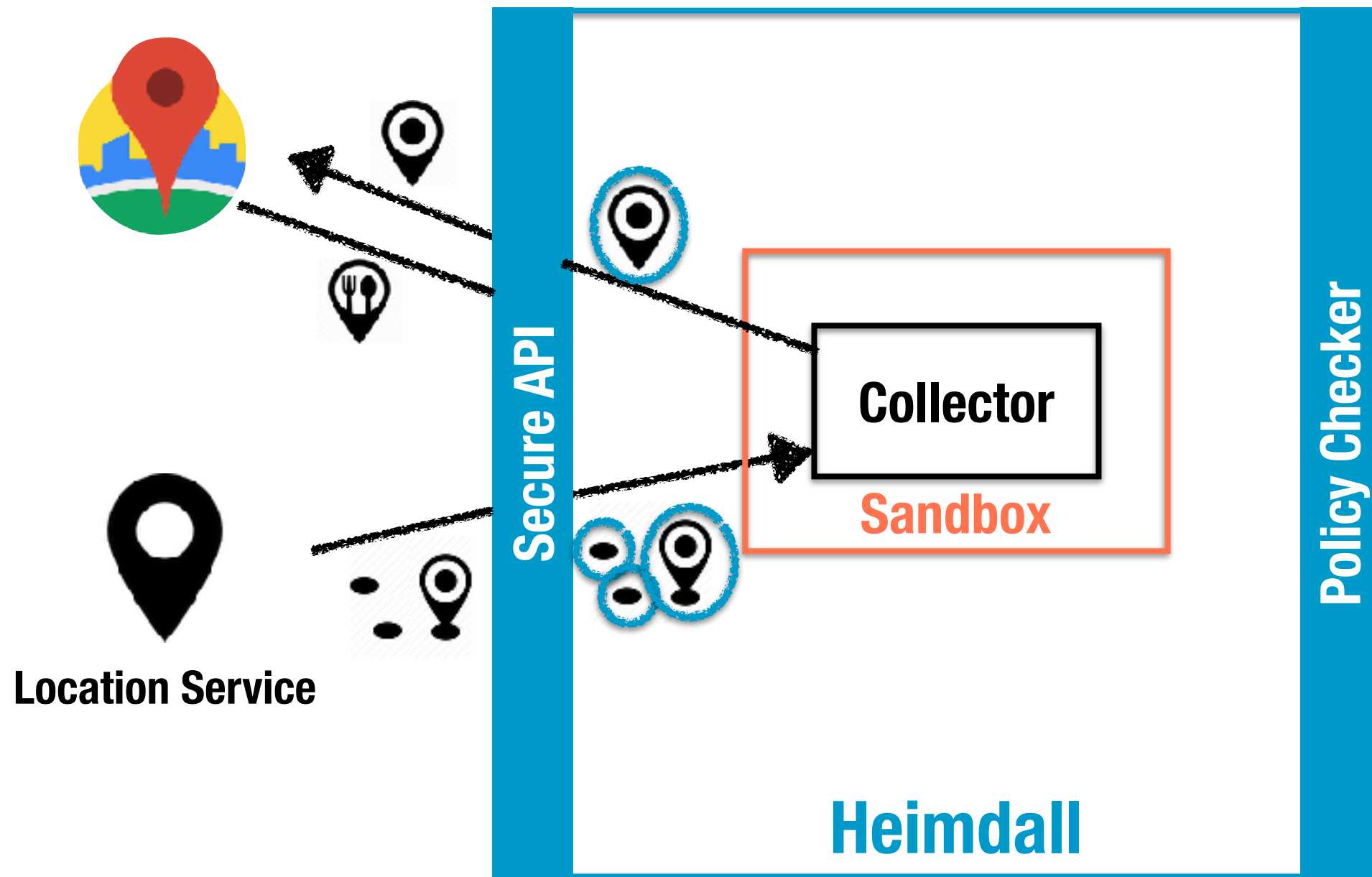
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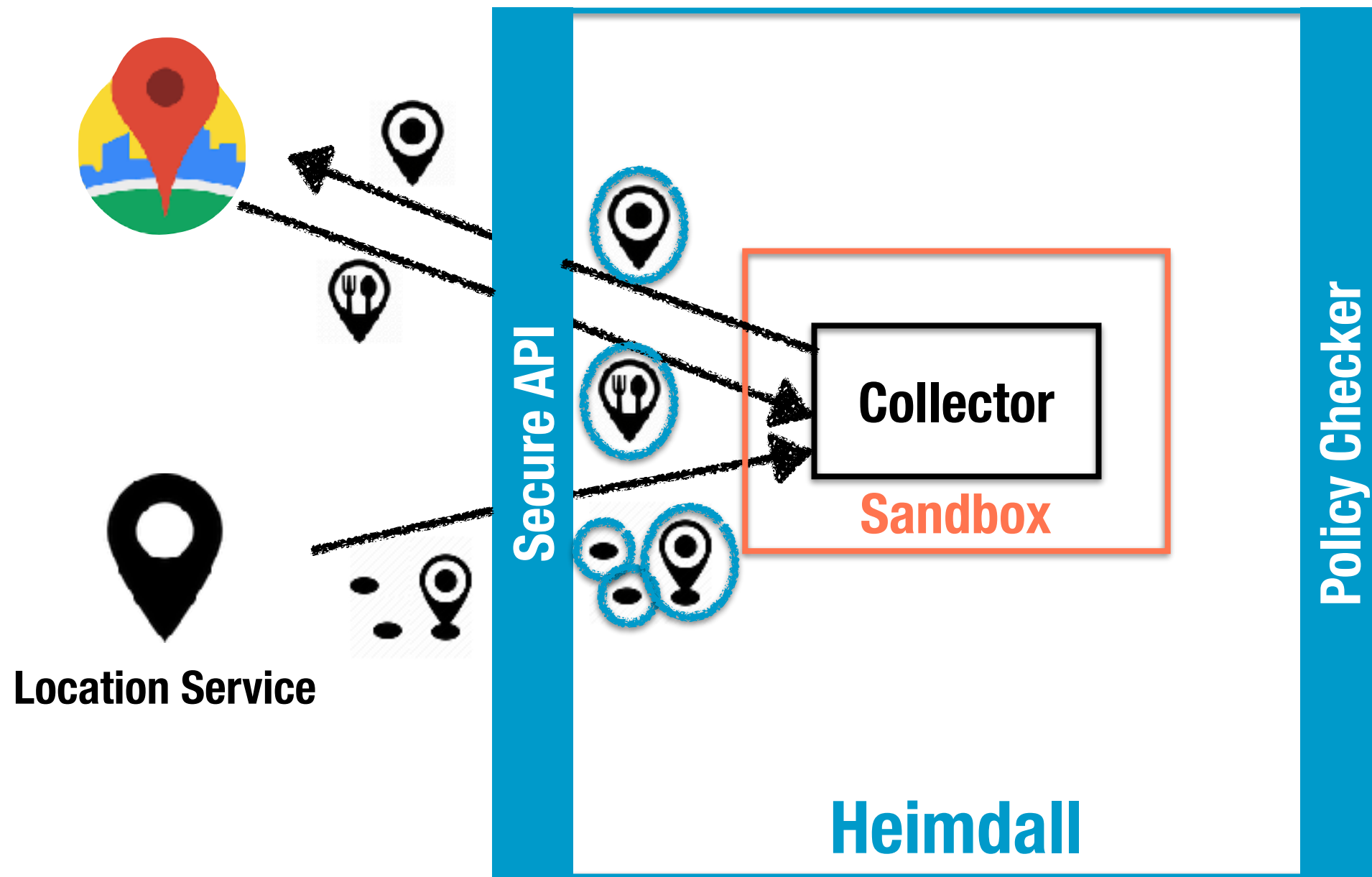
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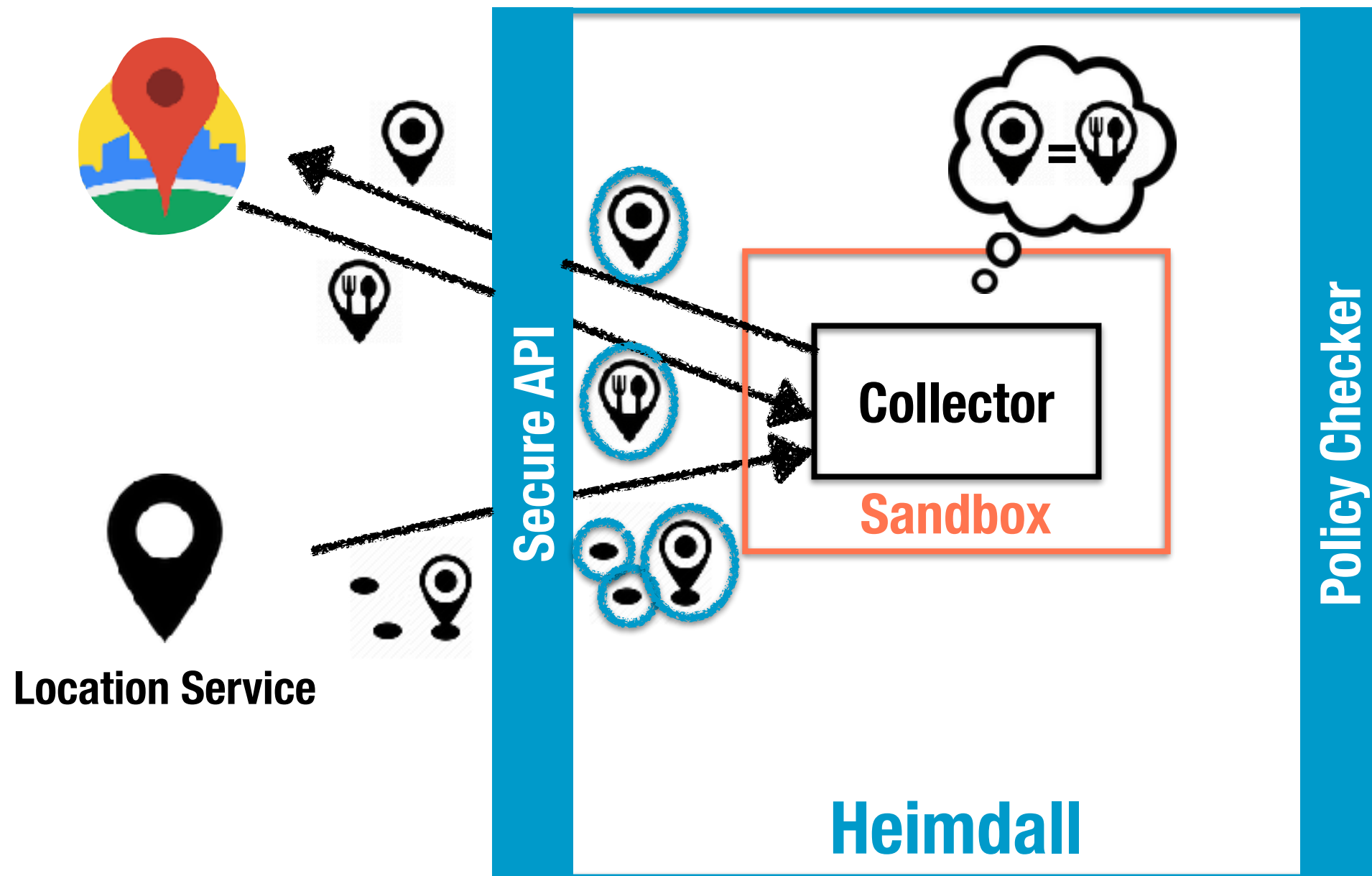
Immutable Blob: <JSON Data, Path, Signature>

Restaurant Collector



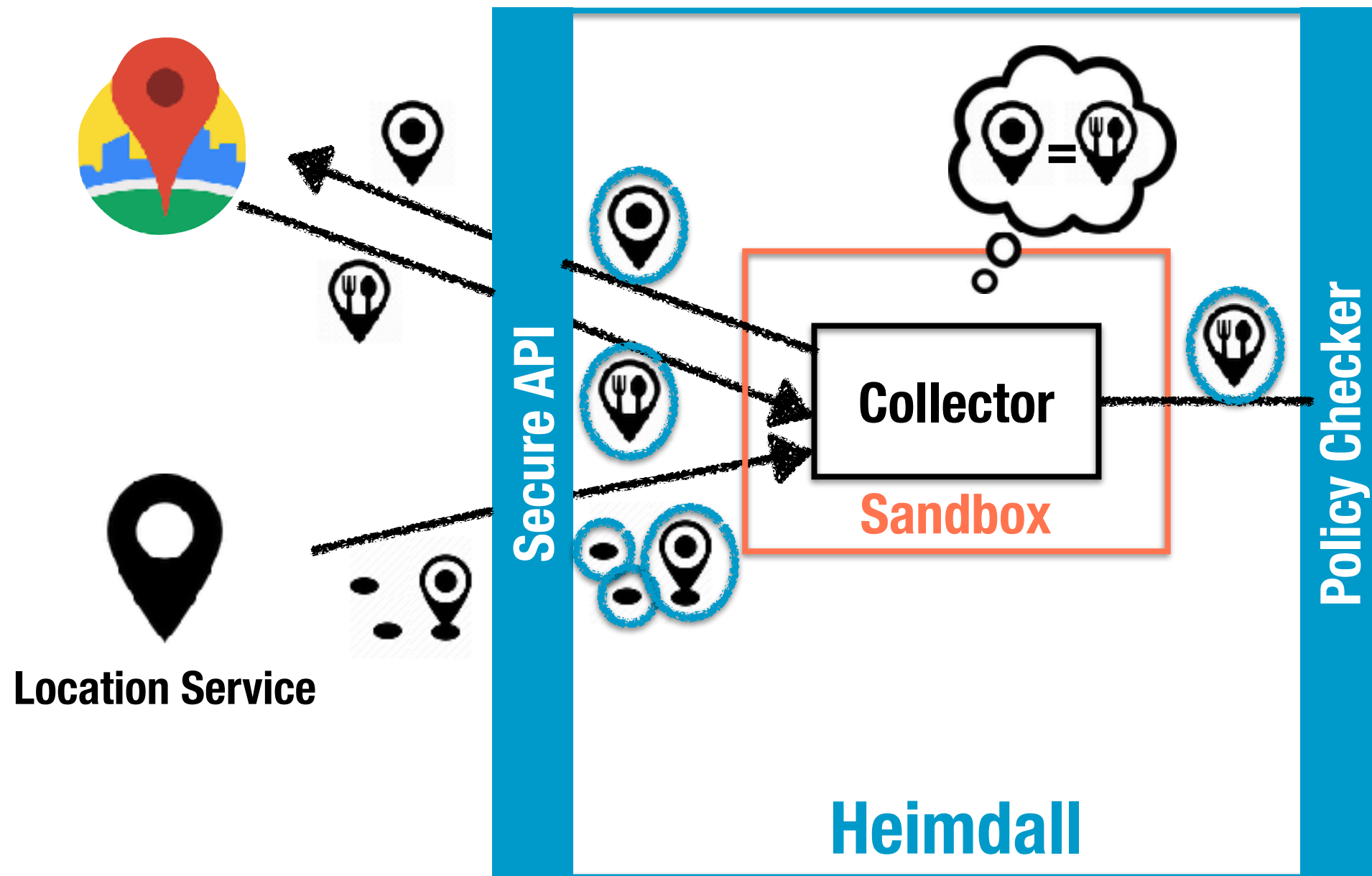
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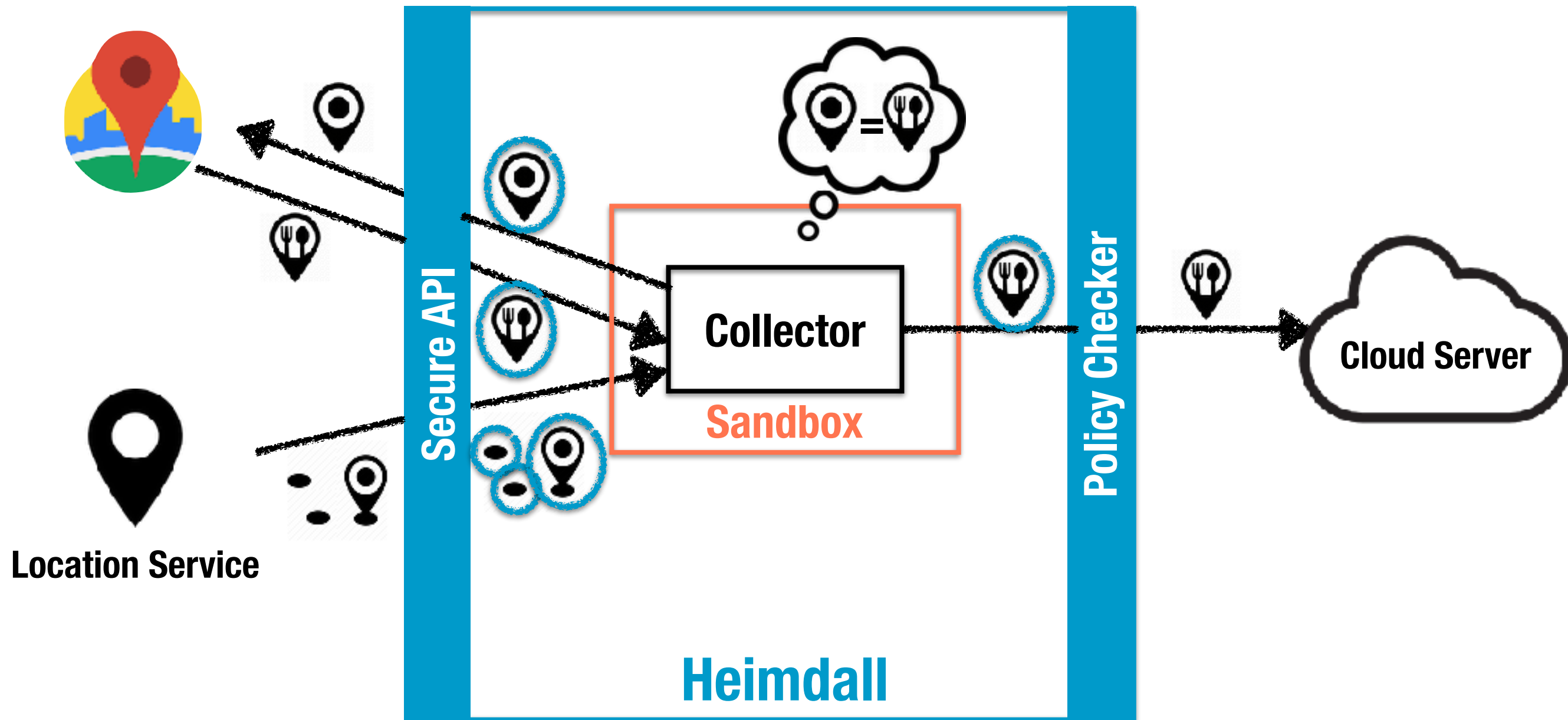
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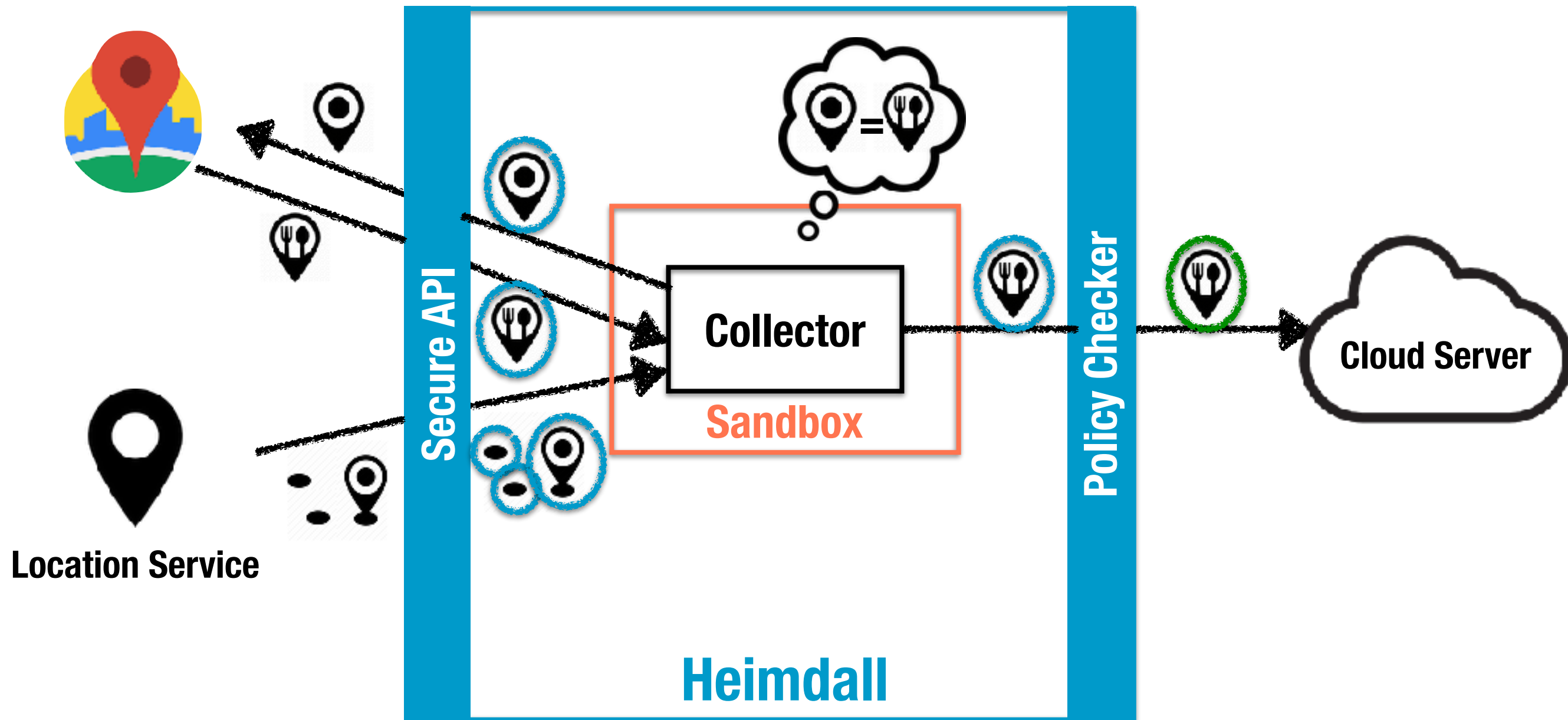
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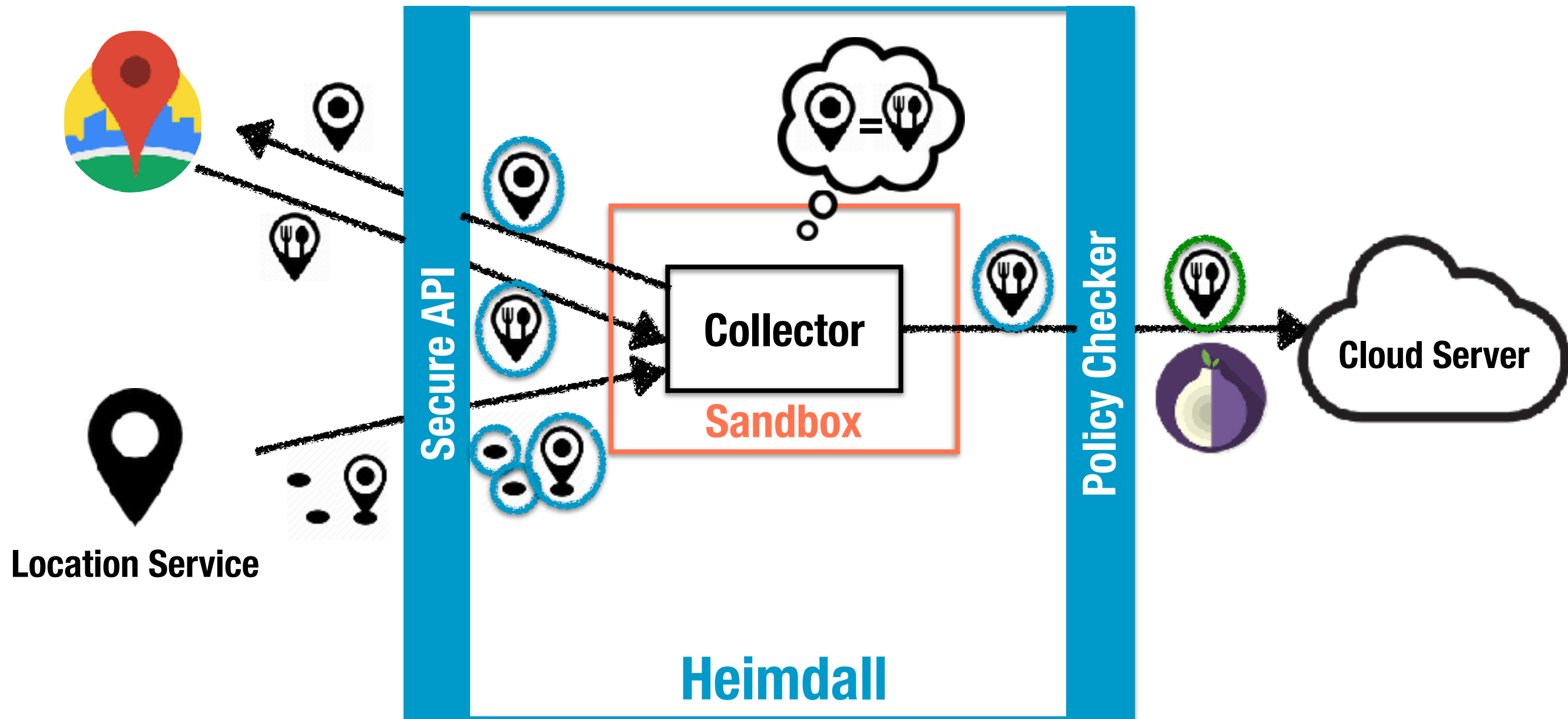
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Restaurant Collector



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Restaurant Collector

```
#Sources:
    FINE_LOCATION
    googleapis:place

#Collects:
    @anonymized
    if (googleapis:place:results:types=="restaurant") :
        submit (googleapis:place:results:name, "Link")
```

Restaurant Collector

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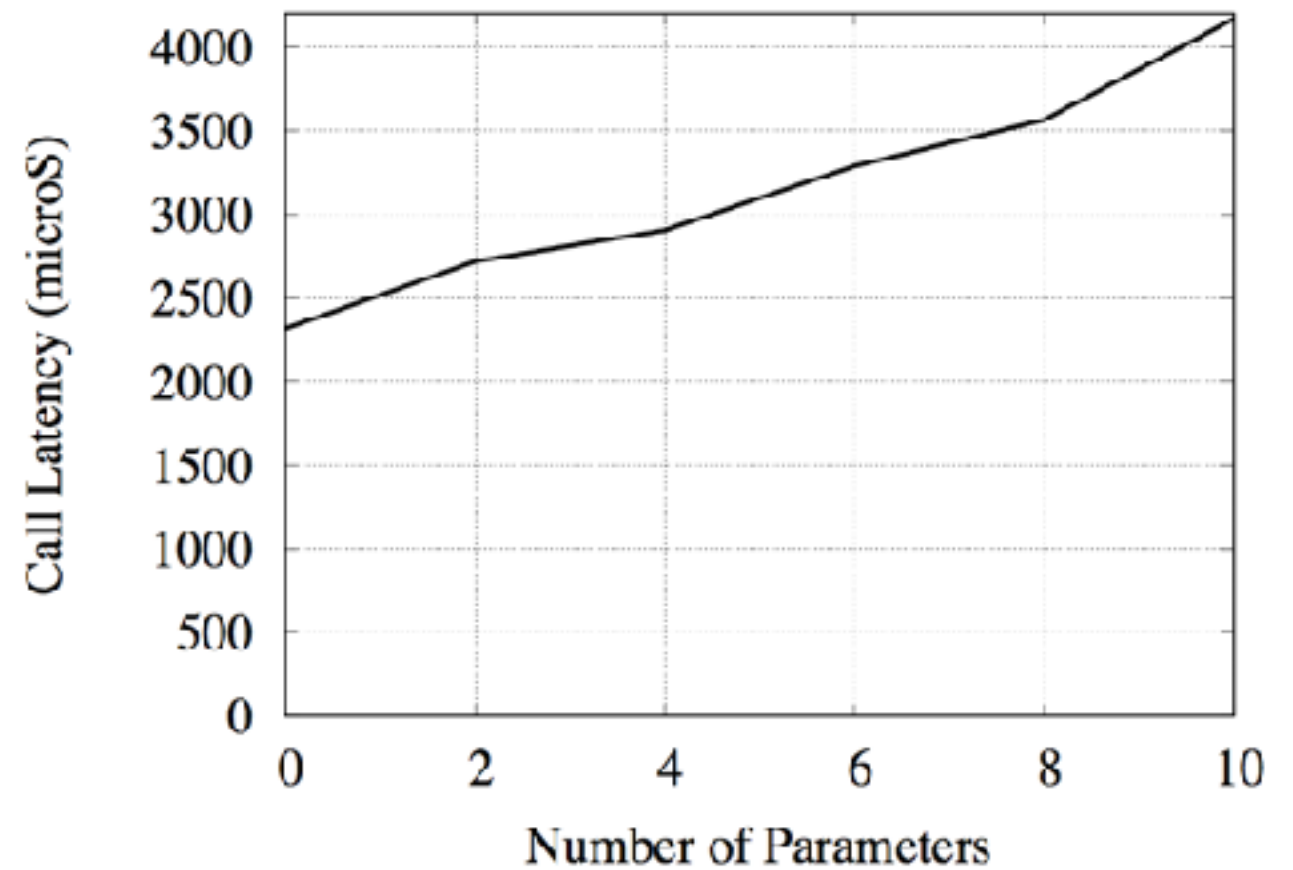
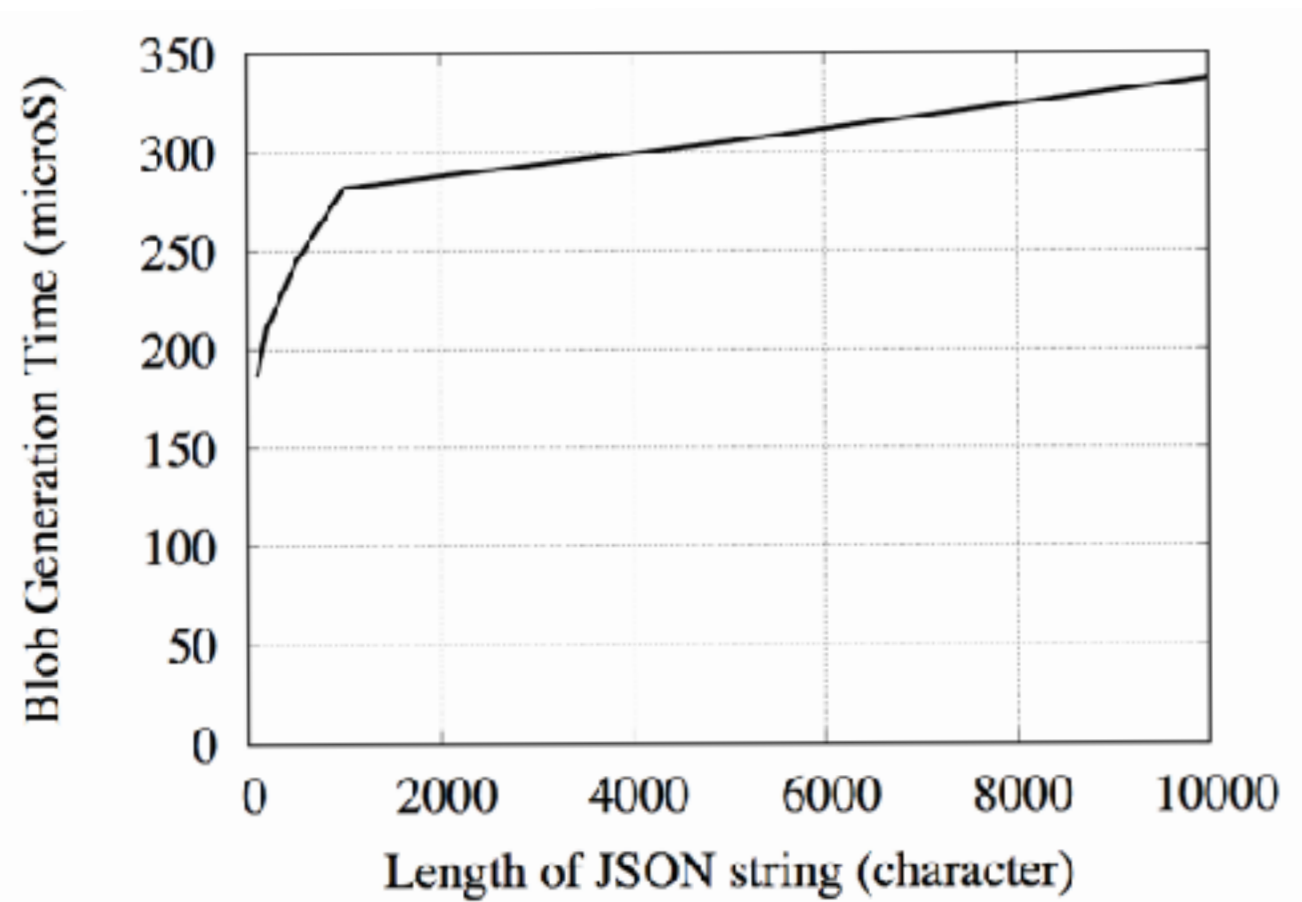
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Supports relational constraints

Evaluation

- How is the performance of Heimdall?
- Can you develop useful collectors using Heimdall?
- Does Heimdall decrease user concerns?

MicroBenchmarks



Likert Scale

1. **Not Concerned** - Select this for actions which pose little to no risk to you or the people living with you.
2. **Mildly Concerned** - Select this for actions which pose a low risk to you or the people living with you, but are useful when used as intended.
3. **Concerned** - Select this for actions which pose a medium risk to you or the people living with you, but are useful when used as intended.
4. **Very Concerned** - Select this for actions which pose a high risk to you or the people living with you, but are useful when used as intended.
5. **Would Not Allow** - Select this for actions which pose a high risk to you or the people living with you and are better left disabled.

Results

Results

- Location
 - Reporting location all the time
 - Reporting location when using the app
 - Reporting name of restaurants

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 - Reporting location all the time
 - Reporting location when using the app
 - Reporting name of restaurants
- Purchase History
 - Reporting purchases all the time
 - Reporting food purchases

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- Location
 - Reporting location all the time
 - Reporting location when using the app
 - Reporting name of restaurants
- Purchase History
 - Reporting purchases all the time
 - Reporting food purchases
- Browser History
 - Reporting all your browsing history
 - Reporting restaurant websites you browsed

Heimdall: A Privacy-Respecting Implicit Preference Collection Framework

- We empirically show that recommendation systems **suffer from sparsity of data**.
- Heimdall allows users to **control what type of data they are sharing** with recommendation systems.
 - This allows recommendation systems to **collect implicit signals while respecting user privacy**.
- We implemented 3 data collectors using Heimdall and evaluated **Heimdall performance** and **user response** to it.