## I. Use Case Description

<table>
<thead>
<tr>
<th>Use Case Name</th>
<th>Food Provenance Portal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Case Identifier</td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td></td>
</tr>
<tr>
<td>Point of Contact</td>
<td>Kiana McNellis, <a href="mailto:mcnelk@rpi.edu">mcnelk@rpi.edu</a></td>
</tr>
<tr>
<td></td>
<td>Vipula Rawte, <a href="mailto:rawtev@rpi.edu">rawtev@rpi.edu</a></td>
</tr>
<tr>
<td></td>
<td>Trilce Encarnacion, <a href="mailto:encart@rpi.edu">encart@rpi.edu</a></td>
</tr>
<tr>
<td>Creation / Revision Date</td>
<td>04/08/2017</td>
</tr>
<tr>
<td>Associated Documents</td>
<td></td>
</tr>
</tbody>
</table>

## II. Use Case Summary

### Goal
US Consumers are increasingly concerned about what is in the foods they purchase for consumption. The US diet is largely dependent on processed foods, and the lack of information about these intermediate goods needs to change. Furthermore, concerns over the health of foods - due to high amounts of processing, non-labeling of GMOs, additives, and contamination - are high, and answers are not easily found. Consumers want to be able to easily find this information and use it in planning their meals. In this research, we are interested in evaluating the use of semantic technologies to provide information about the health impacts of ingredients of processed food items found in most supermarkets, so that consumers can make an informed decision about their consumption.

### Requirements
Allow input of product / barcode. Find the relevant ingredient data, or fallback to generic item. Find health concerns or disease outbreaks, associated with ingredients. Find the worldwide sources for the product & ingredient, along with any specific information provided by producer. Find the production processes associated with growing/making the good.

### Scope
The food provenance portal will support the search for US consumer food products - specifically branded items available in supermarkets and other retail establishments. The system will provide information about ingredient composition and manufacturing process for the food items. Based on the ingredients, the portal will report any links to adverse health effects associated with them, as well as any contamination alerts impacting the ingredients.

### Priority
<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supermarkets &amp; Restaurants</strong> – they want to provide health and environmentally-conscious customers with the best products to improve sales.</td>
<td></td>
</tr>
<tr>
<td><strong>Food &amp; Health boards</strong> – they want to keep track of the sources of foods that people eat &amp; monitor any spikes in illness.</td>
<td></td>
</tr>
<tr>
<td><strong>Food production companies</strong> – want to stay competitive with consumer’s demands</td>
<td></td>
</tr>
</tbody>
</table>

| Description | Consumers and other interested parties will be able to search for relevant information about processed food items available for purchase in the US. The portal will provide data about the ingredient composition of an item. Based on this information, the system will also report on health risks associated with either the ingredient itself, or the manufacturing process used. |

| Actors / Interfaces | ● **Primary**: Consumers looking for information about food sourcing and health.  
● **Primary**: Food Provenance Ontology, provides sourcing information.  
● **Secondary**: Source of information, FDA, CDC  
● **Secondary**: Supermarkets & Restaurants would like to provide health and environmentally-conscious customers with the best products to improve sales. |

| Pre-conditions | ● Reporting by food companies of ingredients used.  
● Reporting of GMO status.  
● Matching of ingredients to production methods  
● Current contamination warnings  
● Health impact of goods  
● Ontologies to match different forms of ingredients  
● Ontologies to match different manufacturing processes |

| Post-conditions | ● List of Ingredients  
○ Associated health impacts  
○ Whether it contains genetically modified organisms  
○ Possible contamination and health alerts  
● Description of production method |

| Triggers | ● **Consumer wants to buy a product**  
● **Retailers and restaurants doing market or product research**  
● **Watchdog group comparing food producers practices** |

| Performance Requirements | Data should be able to be retrieved and displayed within a minute.  
To facilitate this, nightly/weekly data ingestions may be required.  
Data should be able to be added to the system routinely and reused for many queries. |

| Assumptions |  |
| Open Issues |  |
III. Usage Scenarios

Anna

Anna is a consumer from New Hampshire. She is an accountant and mother of 2, and wants to monitor the foods she buys. Anna wants to know what is in the food she buys, and what the effects of each ingredient are. She is interested in avoiding genetically engineered crops. To that end, she needs to find out whether GMOs are present in the ingredients of the product she is interested in purchasing. Anna inputs the product name into the Food Provenance Portal GMO search, and retrieves the list of ingredients in the product that are reported to contain GMOs, and which are certified organic.

Susan

Susan is involved in monitoring the food stocked at the supermarket to ensure that they meet sourcing requirements. She wants to avoid goods that use GMOs and antibiotics. She needs to research each new product that comes in to make sure it meets standards of not having GMO ingredients, as well as monitor previously added products to be notified of any changes. She also needs to make sure that they don’t stock products that have has recent disease outbreaks or contaminations reported. Susan uses the bulk upload of the the Food Provenance Portal, and submits a list of Unique Product Codes to be monitored. The ontology looks these codes and retrieves the information regarding ingredients, GMO reports and antibiotic protocols reported for each product.

Antonio

Antonio is a consumer concerned with additives and chemical ingredients present in the foods he consumes. Since he wants to consume mostly whole foods (with minimal additives), he is interested in researching the ingredient composition of the food items he purchases, and identifying which ingredients contain additives or added chemicals. He scans the barcode of the food product in the Food Provenance Portal, and the ontology retrieves a list of additives for the product. The ontology also does reasoning to provide reasons why each of the additives was used and any negative side effects they might have.

Martha

Martha is a consumer that is interested in healthy food items and she is concerned about negative health impacts associated with processed foods. She would like to know what are the ingredients of the processed foods she buys and whether they pose any health risk. Martha inputs the product name into the Food Provenance Portal search, and the ontology retrieves the ingredient list, and whether any health risks are associated to them.

Updated Usage Scenario: (Reasoning)

Priya

Priya, who has a sweet tooth and is also a healthy eating freak, visits the supermarket and comes across KEEBLER COCONUT DREAMS on the shelf and thinks if she should buy because the cookies in the picture on wrapper look tempting. As she is unsure, she quickly
opens the FP web application, scans the product barcode and gets a straight NO from the app and also receives an alternative as Kashi chocolate almond butter cookies. The reasoning is done as follows:

 Priya likes chocolate+cookies and looking if it is healthy; these criteria will mapped to the ontology saying to narrow down the results to chocolate cookies which have low fat and sodium, and suggests Kashi chocolate almond butter cookies as the best result.

Lisa wants to buy packed food free from carcinogenic food ingredients but obviously cannot remember the harmful carcinogenic chemical names and their effects. Since she wants to buy Kellogg’s Froot Loops, she scans the barcode and gets the result as DO NOT BUY since it has carcinogenic food ingredients.

Kellogg’s Froot Loops has following ingredients:

GMO sugar - GMO class
Corn - Food additive class
Soy Food allergen and Toxic Food ingredients class.
The partially hydrogenated vegetable oil is GMO and contains trans fats.
6 artificial and natural colors on the ingredients list - Artificial flavour and color class.

We will also have a ‘Carcinogenic food ingredients’ class which will have subclasses and the reasoning will be done considering all the classes the ingredients fall into.

IV. Basic Flow of Events

**Narrative:** Often referred to as the primary scenario or course of events, the basic flow defines the process/data/work flow that would be followed if the use case were to follow its main plot from start to end. Error states or alternate states that might occur as a matter of course in fulfilling the use case should be included under Alternate Flow of Events, below. The basic flow should provide any reviewer a quick overview of how an implementation is intended to work. A summary paragraph should be included that provides such an overview (which can include lists, conversational analysis that captures stakeholder interview information, etc.), followed by more detail expressed via the table structure. In cases where the user scenarios are sufficiently different from one another, it may be helpful to describe the flow for each scenario independently, and then merge them together in a composite flow.

<table>
<thead>
<tr>
<th>Basic/Normal Flow of Events</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Step</th>
<th>Actor (Person)</th>
<th>Actor (System)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consumer</td>
<td></td>
<td>Accesses Food Provenance Portal</td>
</tr>
<tr>
<td>2</td>
<td>Consumer</td>
<td></td>
<td>User inputs either: Barcode, Product Name or Product Description.</td>
</tr>
<tr>
<td>3</td>
<td>Food Provenance Portal, <em>data sources</em></td>
<td></td>
<td>Retrieves ingredients data from data sources</td>
</tr>
</tbody>
</table>
4. Food Provenance Portal, data sources and services
   Ontology does reasoning to provide health impacts and usage information for additives.

5. Food Provenance Portal, data sources and services
   Reasoning is used to find similar products with better health or organic characteristics.

6. Food Provenance Portal
   Applies semantic reasoning to infer missing sourcing information and health impacts.

7. Food Provenance Portal
   Displays results and comparisons among similar products based on their properties.

V. Alternate Flow of Events

Narrative: The alternate flow defines the process/data/work flow that would be followed if the use case enters an error or alternate state from the basic flow defined, above. A summary paragraph should be included that provides an overview of each alternate flow, followed by more detail expressed via the table structure.

<table>
<thead>
<tr>
<th>Step</th>
<th>Actor (Person)</th>
<th>Actor (System)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consumer</td>
<td></td>
<td>Accesses Food Provenance Portal</td>
</tr>
<tr>
<td>2</td>
<td>Consumer</td>
<td></td>
<td>User inputs either: Barcode, Product Name or Product Description.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Food Provenance Portal, data sources and services</td>
<td>System does not contain data for this product.</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Food Provenance Portal, data sources and services</td>
<td>Applies semantic reasoning to retrieve data for similar product based on their properties.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Food Provenance Portal</td>
<td>Applies semantic reasoning to infer missing sourcing information and health impacts.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Food Provenance Portal</td>
<td>Displays results and comparisons among similar products.</td>
</tr>
</tbody>
</table>

VI. Use Case and Activity Diagram(s)

Provide the primary use case diagram, including actors, and a high-level activity diagram to show the flow of primary events that include/surround the use case. Subordinate diagrams that map the flow for each usage scenario should be included as appropriate.
Primary use case diagram:

1. Consumer
2. Access Food Provenance Portal
3. Inputs product name into portal’s GMO search
4. Reasoning and Inferring
5. Displays whether product contains GMOs
6. Food Provenance Portal
7. Food Provenance Ontology
8. Data Source
Usage scenario 1:
Usage scenario 2:

1. Access Food Provenance Portal
2. Inputs list of UPCs to be monitored
3. Reasoning and Infering
4. Displays whether products contain CMOs or antibiotics

Susan - Supermarket Manager

Food Provenance Portal
Food Provenance Ontology
Data Source
Usage scenario 3:

- Antonio - Consumer
  - Access Food Provenance Portal
    - Scans Barcode or product name
      - Reasoning and Interpreting
        - Displays additives and added chemicals per ingredient
          - Food Provenance Portal
            - Food Provenance Ontology
              - Data Source
Usage scenario 4:

Access Food Provenance Portal

Inputs Product Name

Martha - Consumer

Reasoning and Inferring

Displays health risks per ingredient

Food Provenance Portal

Food Provenance Ontology

Data Source
Activity Diagram:
Usage scenario Alternate Flow:

**VII. COMPETENCY QUESTIONS**

Provide at least 2 competency questions that you will ask of the vocabulary/ontology/knowledge base to implement this use case, including example answers to the questions.

**EXAMPLE QUESTIONS**

For answering all the below competency questions, the Food Provenance ontology (developed using original concepts as well as importing some available ontologies like the Bio-Portal Food ontology, DBpedia, etc) will be used which will have different classes for food ingredients, additives, artificial color and flavor, food allergen, GMO content, health impact and others (TBD), subclasses, data and object properties.

1) What company makes Tostitos Tortilla Chips?
2) What are the major ingredients of MARANATHA, ORGANIC RAW ALMOND BUTTER CREAMY?
   a) Answer: ORGANIC RAW ALMONDS
      Date Last Updated by Company: 05/01/2015

3) Is MARANATHA, ORGANIC RAW ALMOND BUTTER CREAMY organic?
   a) Answer: No

4) What is the nutritional information for SABRA, ROASTED PINE NUT HUMMUS?
   a) Answer:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Value per 100 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximates</td>
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<td></td>
</tr>
<tr>
<td>Energy</td>
<td>kcal</td>
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<tr>
<td>Protein</td>
<td>g</td>
<td>7.14</td>
</tr>
<tr>
<td>Total lipid (fat)</td>
<td>g</td>
<td>21.43</td>
</tr>
<tr>
<td>Carbohydrate, by difference</td>
<td>g</td>
<td>17.86</td>
</tr>
<tr>
<td>Fiber, total dietary</td>
<td>g</td>
<td>3.6</td>
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<tr>
<td>Sugars, total</td>
<td>g</td>
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<tr>
<td>Minerals</td>
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</tr>
<tr>
<td>Calcium, Ca</td>
<td>mg</td>
<td>71</td>
</tr>
<tr>
<td>Iron, Fe</td>
<td>mg</td>
<td>2.57</td>
</tr>
<tr>
<td>Sodium, Na</td>
<td>mg</td>
<td>464</td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C, total ascorbic acid</td>
<td>mg</td>
<td>0</td>
</tr>
<tr>
<td>Vitamin A, IU</td>
<td>IU</td>
<td>0</td>
</tr>
<tr>
<td>Lipids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatty acids, total saturated</td>
<td>g</td>
<td>3.57</td>
</tr>
</tbody>
</table>
5) What are the health risks associated with ingredients in SARATOGA CHIPS, AMERICA'S FIRST KETTLE CHIP?
   a) Answer:
      
      | Ingredient                                          | Health Risk                                      |
      |----------------------------------------------------|-------------------------------------------------|
      | POTATOES  (WHITE POTATOES, BLUE ADIRONDACK POTATOES, RED ADIRONDACK POTATOES) | None                                           |
      | SUNFLOWER OIL                                      | None                                            |
      | HIMALAYAN SALT                                     | Excess consumption is associated with the following health risks: high blood pressure, heart attack, stroke, heart failure, kidney damage. Reference: [1] |

6) Are there additives on MARANATHA, ORGANIC RAW ALMOND BUTTER CREAMY?
   a) Answer: No

7) Are there chemicals added to HERDEZ, TRADITIONAL GUACAMOLE?
   a) Answer: YES: CITRIC ACID

8) Are there GMOs on HERDEZ, TRADITIONAL GUACAMOLE?
   a) Answer: No

9) Are antibiotics used on BUTTERBALL, PREMIUM YOUNG TURKEY?
   a) Answer: Yes. Notes: Butterball administers antibiotics, under licensed veterinarian's guidance, only as needed to turkeys live healthy lives, free of illness.

10) Are there any disease outbreaks reported for TAYLOR FARMS, ICEBERG LETTUCE?
    a) Answer: No

**UPDATED COMPETENCY QUESTIONS:** (Reasoning)
Q1. Is LAY’S POTATO CHIPS, CLASSIC healthy?
http://www.eatthis.com/best-selling-chips-ranked

LAY’S POTATO CHIPS, CLASSIC has the following ingredients:
1 oz serving (about 15 chips): 160 calories, 10 g fat (1.5 g saturated fat) 170 mg sodium, 15 g carbs, 1 g fiber, < 1 g sugar, 2 g protein

Looking at the fat and sodium content, and that the consumer is looking for chips, an alternative from the ‘chips’ subclass of ‘snacks’ class will be inferred and the following will be recommended.

LAY’S OVEN BAKED POTATO CRISPS, ORIGINAL:
1 oz (about 18 chips): 120 calories, 2 g fat (0 g saturated), 135 mg sodium, 23 g carbs, 2 g fiber, 2 g sugars, 2 g protein

**Similar with cookies (covered in the usage scenario)**
http://www.eatthis.com/most-popular-cookies-in-america-ranked

Q2. Is Nestle’s Raisinets harmful for people with food allergies?

Yes.
Nestle’s Raisinets contains Lecithin and Lecithin is a food allergen, so Raisinets is allergic to people having allergy from soy or soy related food items.

Q3. Is Great value strawberry ice cream healthy?

No.
It is not healthy as it uses artificial colors and flavours which are not healthy to consume.

Q4. Is it good to buy Crab Supreme Leg Style Imitation Crab as I cannot find crab?

*This is an example where multiple sources are looked up for reasoning*
The ingredients are:
Fish Protein (Alaska Pollock and/or Pacific Whiting, MSC Certified), Water, Egg Whites, Corn Starch, Sugar, Modified Tapioca Starch, Contains 2% or Less of: Snow Crab Meat, Natural and Artificial Flavor (Extracts of Blue Crab, Snow Crab, Lobster, and Alaska Pollock), King Crab Meat, Rice Wine (Water, Rice, Koji), Sea Salt, Sorbitol, Carrageenan, Yam Flour, Potassium Chloride, Disodium Inosinate, Sodium Pyrophosphate, Soy Lecithin, Carmine, Paprika, Color Added.

Artificial flavor and Color from toxic ingredients class
Soy lecithin from food allergens class

Combining the sources, it would be inferred that this is not safe and healthy to buy.

Q5. Does Great Value Milk Chocolate Hot Cocoa Mix have real cocoa flavor?

No.
Since it has artificial flavor it does not have real cocoa in it and you can go for the one which has real cocoa.

Q6. Does Swiss Miss Milk Chocolate Hot Cocoa Mix contain toxic ingredients?

*This is an example where multiple sources are looked up for reasoning*
*We will have a class of toxic food ingredients which have subclasses: (a) Food Additives (b) Artificial Sweeteners (c) Artificial Food Colorings (d) Artificial food flavours*
Yes.
Reasoning from multiple sources: It contains:
Corn Syrup - Food Additives
Carrageenan - Food Additives
Artificial Flavor - Artificial food flavours
Dipotassium Phosphate - Food Additives

**UPDATED COMPETENCY QUESTIONS:**

- Lisa wants to buy Mars M&M candies for her kid and wants to make sure if it is safe.
  
  M&M candies is a **Food**
  and **hasIngredient Additive**
  which has subclass **ColorAdditive**
  which has subclass **CertifiedColor**
  which has instances Blue1, Blue2, Red40, Yellow5 and Yellow6 found in US M&M
  and these instances have **hasHealthHazard ChromosomalDamage, BrainTumor, Lymphomas, Hyperactivity, Asthma, Insomnia, Aggression, ThyroidTumor**
  and thus M&M candies are categorized as a “Health Hazard” NOT safe to consume.

- Priya wants to buy Healthy Choice Chicken Noodle Soup and wants to make sure if it is safe.
  
  Healthy Choice Chicken Noodle Soup is a **Food**
  and **hasIngredient Additive**
  which has subclass **FlavorAdditive**
  which has subclass **FlavorEnhancer**
  which has instances HydrolyzedVegetableProtein found in Healthy Choice Chicken Noodle Soup
  and this instance further has **hasIngredient MonoSodiumGlutamate**
  which has **hasHealthHazard Headache, Eczema, WeaknessOfArmsOrLegs, BurningSensationOfMouthHeadNeck**
  and thus Healthy Choice Chicken Noodle Soup is categorized as a “Health Hazard” NOT safe to consume.

** We've a clearer picture of ontology this time since we developed classes hierarchy, properties and relationships (can be found here) which shows how the ontology will be used to reason and infer. We'll be developing reasoning rules in the next assignment and will also consolidate the competency questions and the usage scenarios to reflect both straight look up and reasoning functionalities. **

** We developed ontology which covers the classes and properties listed in the curated terms list and also added a few terms to the list.**
We revised the ontology by adding classes, restrictions and instances.

**We revised the ontology by adding classes, properties, restrictions, instances and annotations.**

## VIII. Resources

In order to support the capabilities described in this Use Case, a set of resources must be available and/or configured. These resources include the set of actors listed above, with additional detail, and any other ancillary systems, sensors, or services that are relevant to the problem/use case.

<table>
<thead>
<tr>
<th>Name</th>
<th>Category</th>
<th>Description</th>
<th>Link</th>
<th>Secondary</th>
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</thead>
<tbody>
<tr>
<td>Open Food Facts</td>
<td>Database</td>
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<td>Database</td>
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<tr>
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<td>Database</td>
<td>All food additives</td>
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<td>Companies that completed consultation on a GE food</td>
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<td>Genetically modified food approval</td>
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<td><strong>AGROVOC Thesaurus</strong></td>
<td>Thesaurus</td>
<td>controlled vocabulary covering all areas of interest of the Food and Agriculture Organization</td>
<td><a href="http://aims.fao.org/vest-registry/vocabularies/agrovoc-multilingual-agricultural-thesaurus">http://aims.fao.org/vest-registry/vocabularies/agrovoc-multilingual-agricultural-thesaurus</a></td>
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<td><strong>BBC Food Ontology</strong></td>
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<td><a href="http://www.bbc.co.uk/ontologies/fo">http://www.bbc.co.uk/ontologies/fo</a></td>
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<td>Bio Portal Food ontology</td>
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<td><a href="http://dbpedia.org/ontology/Food">http://dbpedia.org/ontology/Food</a></td>
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<td>Goodrelations food product ontology</td>
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<td><a href="https://github.com/ailabitmo/food-ontology">https://github.com/ailabitmo/food-ontology</a></td>
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<td>USDA Thesaurus</td>
<td>Thesaurus</td>
<td><a href="https://agclass.nal.usda.gov/download.shtml">https://agclass.nal.usda.gov/download.shtml</a></td>
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**IX. REFERENCES AND BIBLIOGRAPHY**

List all reference documents – policy documents, regulations, standards, de-facto standards, glossaries, dictionaries and thesauri, taxonomies, and any other reference materials considered relevant to the use case.

Available:
http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Publications/Mar


X. Notes

There is always some piece of information that is required that has no other place to go. This is the place for that information.