Measuring Intelligence, Surveillance, and Reconnaissance Effectiveness at the United States Central Command

Data Visualization Tool Documentation

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Preface

This tool is intended to assist the U.S. Central Command (CENTCOM) Directorate of Intelligence (J2) in improving the quality, effectiveness, and efficiency of its intelligence, surveillance, and reconnaissance (ISR) assessments.

The research underlying this tool was sponsored by CENTCOM J2 and conducted within the Cyber and Intelligence Policy Center (CIPC) of the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense intelligence enterprise.

For more information on the RAND Cyber and Intelligence Policy Center, see www.rand.org/nsrd/intel or contact the director (contact information is provided on the webpage).

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CHAPTER ONE

Introduction

The RAND Corporation research report "Measuring Intelligence, Surveillance, and Reconnaissance Effectiveness at the United States Central Command" describes research and analysis to aid CENTCOM J2 in developing repeatable, scalable, data-informed support for measuring the effectiveness of its intelligence, surveillance, and reconnaissance (ISR) resources. To aid in that objective, our RAND National Defense Research Institute project team used Tableau to create a visualization tool that allows CENTCOM to display the performance and effectiveness of its support to ISR roles, sub-roles, and activities.[1] The various visualizations provide both a high-level overview of CENTCOM ISR and a more nuanced understanding of the differences between regions, operations, platforms, sensors, and other variables we considered.

Although designed to display data related to CENTCOM ISR support, the visualization could be adapted to a number of different uses. It may be most applicable for similar organizations, such as the Joint Staff and other U.S. Department of Defense geographic and functional Combatant Commands. This visualization tool should also be of interest to organizations and stakeholders inside and outside the federal government that conduct intelligence activities of any type or assess mission performance or effectiveness.

The basic structure of the tool is as follows:

- Admin: provides administrative information about the file and supporting documents
- How To: describes the following dashboards and how to interact with the visualization
- Overview: highlights the status of core functions
- Map: highlights status of core functions by geographic area
- Platform Comparison: highlights the similarities and differences between two platforms
- Sensor Comparison: highlights the similarities and differences between two sensors
- Missing Data: highlights the overall percentage of null measure of performance (MoP) values.

The dashboards are interactive, with structures that ask major questions of the data but still allow users to seek out answers that are relevant to their needs. We envisage that visualizations such as these could be used not only to display data in an intuitive fashion, but also to facilitate sharing information among operators and decisionmakers.

This document is intended to serve as a guide for how to interact with the visualization tool, adapt the workbook for individual user needs, and completely reconstruct it. It is not a

[1] Tableau, "Tableau Desktop and Web Authoring Help," website, version 2018.2, October, 2019. As of April 3, 2020: https://help.tableau.com/current/pro/desktop/en-gb/default.htm

tutorial for how to use Tableau; a basic familiarity with the program is required. For more detailed information on Tableau functionality, please visit the Tableau website.

CHAPTER TWO

Importing CENTCOM Data into the Workbook

Although this document is intended provide sufficient instruction to allow a user to replicate the workbook from scratch, it is possible to use this workbook directly with a different data source. To do so, simply replace the data source by editing the data connection in the Data Source tab. If the new data source has the same field names (column headers) as the data source being replaced, no additional steps are needed; the visualizations will update to reflect the new data. Please note, however, that if field names do not match, or if the data types do not match, the affected fields will become invalid (denoted with an exclamation point) and the visualizations will not render correctly. To correct this, right-click on the invalid field in the data pane (accessed from any worksheet) and select *Replace References* to map the invalid field onto the correct field from the new data source.

The business rules used to determine whether a metric met an objective or threshold were arbitrarily determined for visualization purposes. For use with actual data, the calculations should be modified to match user criteria. Instructions for how to modify these calculations may be found in the next chapter.

CHAPTER THREE

How to Reconstruct the Workbook

The instructions below explain the process and steps used to construct the workbook, which was created in Tableau version 2018.2 in response to sponsor needs. The file will open in newer versions, although some aspects of the interface might change according to the version and operating system used.

The instructions below provide explicit directions for how to create the Tableau workbook that this tool supports. These instructions may prove helpful for users interested in expanding the functionality of the tool, understanding the mechanics of the tool, or who are operating a version of Tableau that is not compatible with the provided workbook. These instructions largely ignore minor formatting, and while explanation for nonintuitive steps is provided, it is expected that the user has basic familiarity with Tableau software. There is a wide range of publicly available resources that describe the features of Tableau and how to construct sheets and dashboards, and this report does not attempt to duplicate that content.

Data Preparation

Data Preprocessing in Excel

Due to classification restrictions of the authentic data owned by CENTCOM, an Excel file of synthetic data was created to serve as a proxy data source for this workbook. The Excel file is included in the packaged Tableau workbook. For more information on the definitions of the chosen fields, please refer to the RAND research report "Measuring Intelligence, Surveillance, and Reconnaissance Effectiveness at the United States Central Command."[1] Table 3.1 lists the 19 Excel field names and their data roles. A screenshot of the data fields in the synthetic data file is also provided in Figure 3.1. For simplicity, all of the continuous measures are percentages ranging from 0 to 100 percent.

Hierarchies

To facilitate correct linkages between data elements, the following metrics should be organized into hierarchies:

- Role
  - Sub-role
    - Activity
- Country
  - Region

[1] David Luckey, Bradley Knopp, Sasha Romanosky, Amanda Wicker, David Stebbins, Cortney Weinbaum, Sunny D. Bhatt, Hilary Reininger, Yousuf Abdelfatah, and Sarah Heintz, *Measuring Intelligence, Surveillance, and Reconnaissance Effectiveness at the United States Central Command*, Santa Monica, Calif.: RAND Corporation, RR-4360-OSD, forthcoming.

Table 3.1
Field Names and Data Roles

Excel Field Name	Tableau Data Type	Tableau Data Role
Date	Date	Continuous dimension
Role	String	Discrete dimension
Sub-role	String	Discrete dimension
Activity	String	Discrete dimension
Country	String	Discrete dimension
Region	String	Discrete dimension
Operation	String	Discrete dimension
Platform	String	Discrete dimension
Sensor	String	Discrete dimension
Validated Requirements Denied	Number (whole)	Continuous measure
Tasking Denied Platform	Number (whole)	Continuous measure
Tasking Denied Sensor	Number (whole)	Continuous measure
First Choice Unavailable	Number (whole)	Continuous measure
Sortie Satisfaction	Number (whole)	Continuous measure
On Watch	Number (whole)	Continuous measure
Operational Readiness	Number (whole)	Continuous measure
Standing Requirements Satisfied	Number (whole)	Continuous measure
Ad Hoc Requirements Satisfied	Number (whole)	Continuous measure
Sensor Operational	Number (whole)	Continuous measure

NOTE: If the data support increased granularity, "Date & Time" may be selected as the Tableau data type. The *Date* type displays data as Month/Day/Year.

Figure 3.1
Excel Data Fields in Synthetic Data File

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Date	Activity	Sub-Role	Role	Region	Operation	Platform	Sensor	Validated R	Tasking Denied Platform	Tasking Denied Sensor	First Choice	Sortie Satis	On Watch F	Operationa	Standing Cc	Ad Hoc Coll	Sensor Availab	Country
2	1/12/18		1.2	1. FPS	Farah	Stranger	Ducky	IR	85	80	88	93	80	75	83	100	86	73	Afghanistan
3	8/22/20	2.1.1	2.1	2. OPS	Kabul	Throat	Ducky	EMR	99	81	88	97	81	99	94	97	100	77	Afghanistan
4	11/15/17	4.2.1	4.2	4. KNK	Homs	Magic	Ducky	PEEPER	97	81	80	90	94	72	76	78	66	76	Syria

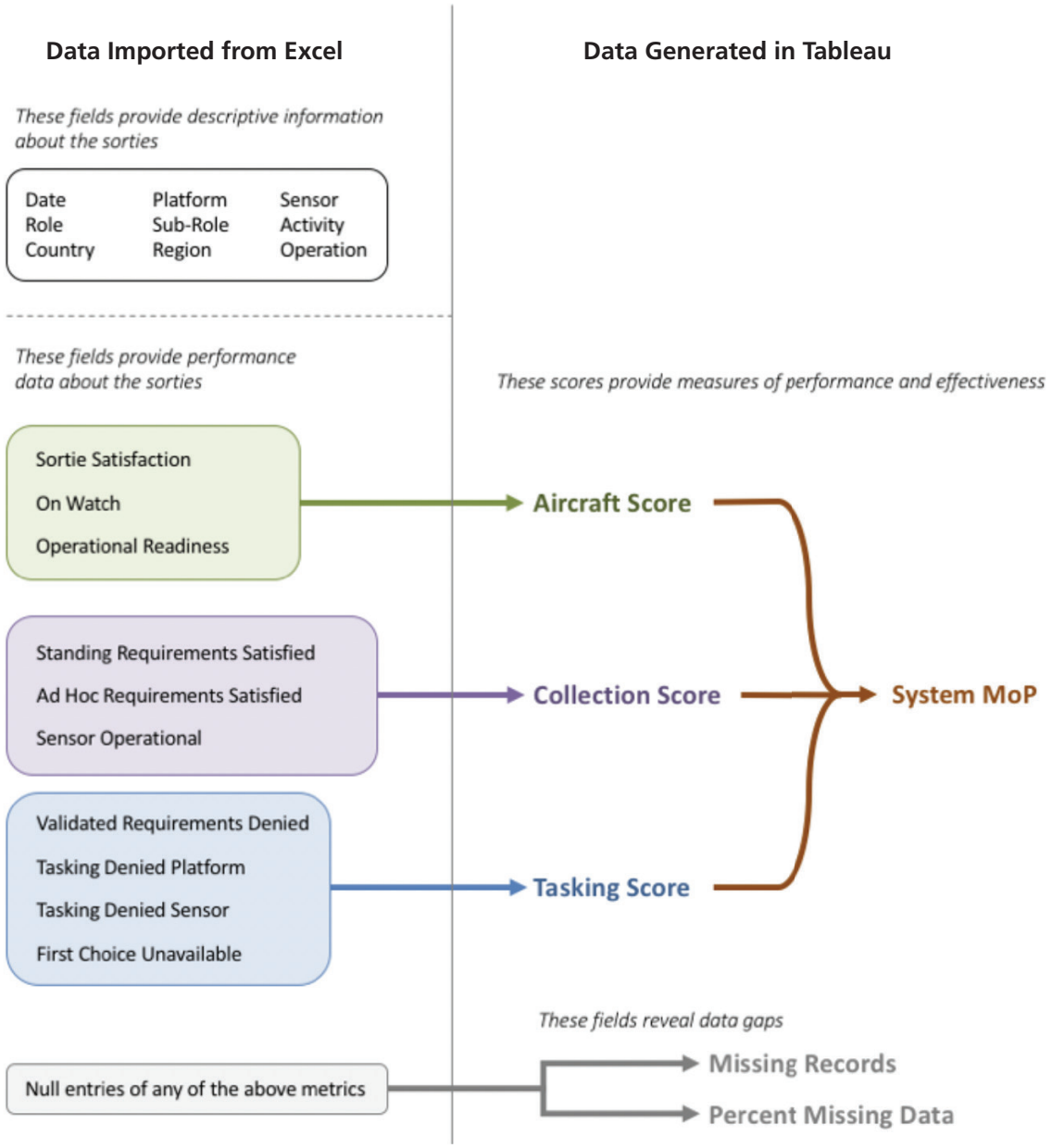
Calculated Fields

We created calculated fields (also known more generally as business rules) in Tableau to determine whether a metric met an objective or threshold. These were set arbitrarily for visualization purposes. For use with actual data, the calculations should be modified to match user criteria. The metrics used in this visualization were designed for CENTCOM ISR support, but the basic structure—hierarchical measures of performance and effectiveness that aggregate to provide assessments of overall system status—is agnostic to subject area. The relationship between data fields imported from Excel (or a similar application) and the data fields computed in Tableau is depicted in Figure 3.2.

Aircraft Score

The Aircraft Score was created as an aggregation of three related metrics:

Figure 3.2
Excel and Tableau Data Fields



- Sortie Satisfaction
- On Watch
- Operational Readiness

Null values were removed from the data set, and the remainder of the calculation below was used to assign values of 1, 2, or 3 to the output. See Box 3.1.

Collection Score

The Collection Score was created as an aggregation of three related metrics:

Box 3.1
Aircraft Score Calculation

```
Aircraft Score Calculation
IF      ISNULL([Sortie Satisfaction])
        THEN NULL
ELSEIF  ISNULL([On Watch])
        THEN NULL
ELSEIF  ISNULL([Operational Readiness])
        THEN NULL

ELSEIF  [Sortie Satisfaction]      > 80 AND
        [On Watch]                 > 80 AND
        [Operational Readiness]    > 80
        THEN 3
ELSEIF  [Sortie Satisfaction]     < 60 OR
        [On Watch]                < 60 OR
        [Operational Readiness]    < 60
        THEN 1
ELSE 2
END
```

- Standing Requirements Satisfied
- Ad Hoc Requirements Satisfied
- Sensor Operational

Null values were removed from the data set, and the remainder of the calculation below was used to assign values of 1, 2, or 3 to the output. See Box 3.2.

Box 3.2
Collection Score Calculation

```
Collection Score Calculation
IF      ISNULL([Standing Requirements Satisfied])
        THEN NULL
ELSEIF  ISNULL([Ad Hoc Requirements Satisfied])
        THEN NULL
ELSEIF  ISNULL([Sensor Operational])
        THEN NULL

ELSEIF  [Standing Requirements Satisfied]    > 80 AND
        [Ad Hoc Requirements Satisfied]      > 80 AND
        [Sensor Operational]                 > 80
        THEN 3
ELSEIF  [Standing Requirements Satisfied]    < 70 OR
        [Ad Hoc Requirements Satisfied]      < 70 OR
        [Sensor Operational]                 < 70
        THEN 1
ELSE 2
END
```

Tasking Score

The Tasking Score was created as an aggregation of four related metrics:

- Validated Requirements Denied
- Tasking Denied Platform
- Tasking Denied Sensor
- First Choice Unavailable

Note that due to the manner in which these variables were defined, low scores indicate higher performance. Null values were removed from the data set, and the remainder of the calculation below was used to assign values of 1, 2, or 3 to the output. See Box 3.3.

Box 3.3
Tasking Score Calculation

Tasking Score Calculation

```
IF      ISNULL([Validated Requirements Denied])
        THEN NULL
ELSEIF  ISNULL([Tasking Denied Platform])
        THEN NULL
ELSEIF  ISNULL([Tasking Denied Sensor])
        THEN NULL
ELSEIF  ISNULL([First Choice Unavailable])
        THEN NULL

ELSEIF  [Validated Requirements Denied]    < 10 AND
       ( [Tasking Denied Platform]          < 10 OR
        [Tasking Denied Sensor]            < 10) AND
        [First Choice Unavailable]          < 10
        THEN 3
ELSEIF  [Validated Requirements Denied]    > 30 OR
        [Tasking Denied Platform]          > 30 OR
        [Tasking Denied Sensor]            > 30 OR
        [First Choice Unavailable]         > 30
        THEN 1
ELSE 2
END
```

System Measure of Performance

The System MoP metric was created as an aggregation of the three scores described above:

- Aircraft Score
- Collection Score
- Tasking Score

Null values were removed from the data set, and the remainder of the calculation below was used to assign values of 1, 2, or 3 to the output. See Box 3.4.

Box 3.4
System MoP Calculation

System MoP Calculation

```
IF      ISNULL([Aircraft Score])
        THEN NULL
ELSEIF  ISNULL([Collection Score])
        THEN NULL
ELSEIF  ISNULL([Tasking Score])
        THEN NULL

ELSEIF  [Aircraft Score] = 1 OR
        [Collection Score] = 1 OR
        [Tasking Score] = 1
        THEN 1
ELSEIF
        [Aircraft Score] = 3 OR
        [Collection Score] = 3 OR
        [Tasking Score] = 3
        THEN 3
ELSE 2
END
```

Displaying Outputs

This output was later color-coded on each sheet by assigning the Measure Values "AVG(Aircraft Score),"[2] "AVG(Collection Score)," "AVG(Tasking Score)," and "AVG(System MoP)" to colors in the Marks card. The values were assigned as follows:

- 1 = RED
- 2 = YELLOW
- 3 = GREEN

As the average scores ranged continuously from 1–3, a five-stepped color scale was selected to depict the intermediate values.

Missing Data

This dimension was defined with the simple calculation "ISNULL([System MoP])". The data type is Boolean, with *True* signifying missing data (presence of null values) and *False* signifying complete data (absence of null values).

Missing Records

Missing Records is a calculated field that, when summed, generates a count of the number of sorties flown that did not include performance data desired information. It is defined in Box 3.5.

[2] Data that were not simple counts were aggregated through averages. More complex weighting of data may be appropriate for some users.

Box 3.5
Missing Records Calculation

Missing Records Calculation
IF ISNULL([System MoP]) THEN 1 ELSE 0 END

Missing Data Percentage

When averaged, the calculated field *Missing Data Percentage* allows the percentage of sorties missing performance data to be depicted for any aggregation of data. It is defined in Box 3.6.

Box 3.6
Missing Data Percentage Calculation

Missing Data Percentage Calculation
IF ISNULL([System MoP]) THEN 100 ELSE 0 END

NOTE: Although *Missing Records* may appear redundant with *Missing Data Percentage*, the calculated fields were created separately for more intuitive incorporation into the ultimate dashboards.

Building Dashboards

Overview

Component Sheets

Follow the instructions below to construct each of the sheets in the Overview dashboard:

Role

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Role to Label on the Marks card.
6. Add Date to the Filters card. Select "Range of Dates."
7. Add Missing Data to the Filters card. Select "False."[3]
8. Add AVG(System MoP), Platform, Sensor, Operation, Country, and Region to the Filters card. Select "Use all" for each.

Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.

[3] This removes entries that are missing performance data from the evaluation and display.

4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Sub-role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Activity to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Activity to the Filters card. Exclude null values.[4]

Platform

1. Create a new sheet.
2. Place Platform on the Rows shelf.
3. Set Marks card to Shape (circles).
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign AVG(System MoP) to Tooltip on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Sensor

1. Create a new sheet.
2. Place Sensor on the Rows shelf.
3. Set Marks card to Shape (triangles).
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign AVG(System MoP) to Tooltip on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Scores

1. Create a new sheet.
2. Place Measure Names on the Rows shelf.
3. Add Measure Names to the Filters card. Select "Aircraft Score, Collection Score, Tasking Score."
4. Set Marks card to Shape (squares).

---

[4] This is an aesthetic choice. In the synthetic data used as the data source for this workbook, some sub-roles do not possess activities. Adding this filter is necessary to avoid an empty square from appearing when a sub-role without an activity is selected but is not necessary if all sub-roles possess activities.

5. Assign Measure Values to Color on the Marks Card. Click on the down arrow to set the measure to "Average."
6. Add Missing Data to the Filters card. Select "False."

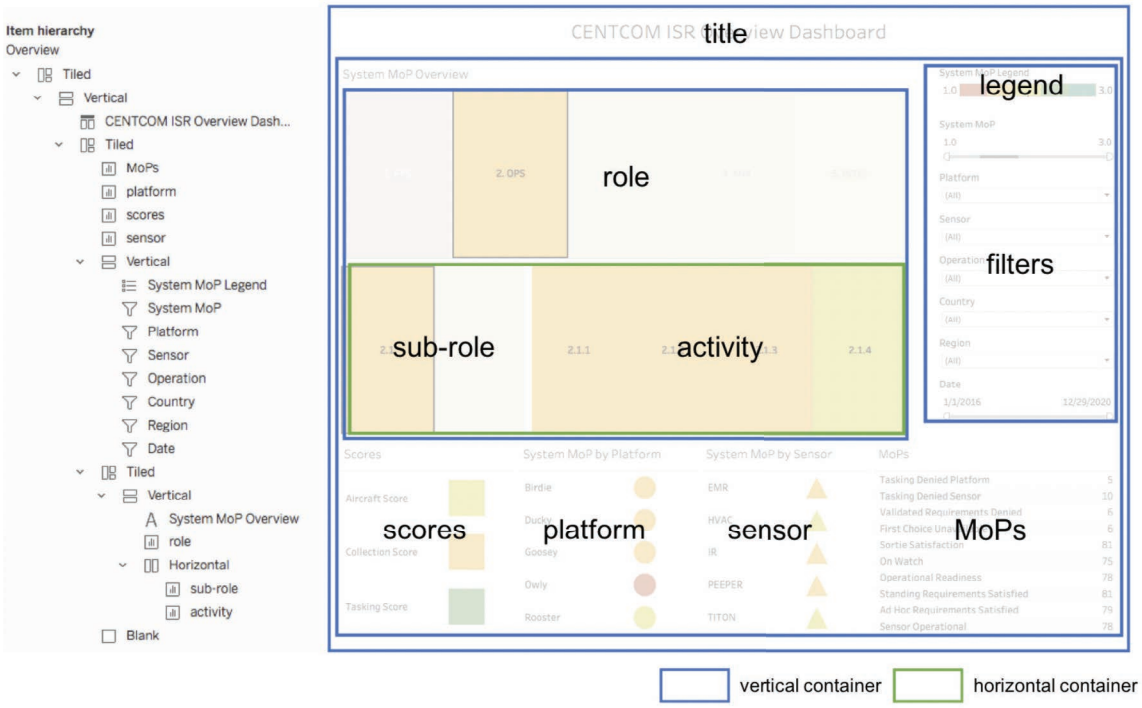
MoPs

1. Create a new sheet.
2. Place Measure Names on the Rows shelf.
3. Add Measure Names to the Filters card. Select "Ad Hoc Requirements Satisfied, On Watch, Operational Readiness, First Choice Unavailable, Tasking Denied Platform, Tasking Denied Sensor, Sensor Operational, Sortie Satisfaction, Standing Requirements Satisfied, Validated Requirements Denied."
4. Assign Measure Values to Label on the Marks card. Click on the down arrow to set the measure to "Average."
5. Add Missing Data to the Filters card. Select "False."

Overview Dashboard Assembly

1. Create a new dashboard.
2. Place horizontal and vertical containers as depicted in Figure 3.3.

Figure 3.3
Layout of Overview Dashboard



3. Add sheets as indicated in Figure 3.3.
4. Add the System MoP Legend by selecting the down arrow→Legend→Color Legend (Avg. System MoP) from any of the dashboard sheets that have colors.
5. Add the following filters by selecting the down arrow→Filters from the role sheet on the dashboard: System MoP, Platform, Sensor, Operation, Country, Region, Date.
6. For all filters, select the down arrow→Apply to Worksheets→Selected Worksheets→All on dashboard.
7. From the menu bar, select Dashboard→Actions...
   a. Create action "deselect role/sub-role hide sub-role/activity" by making the selections in Figure 3.4.[5]
   b. Create action "select role/sub-role/activity filter overview sheets" by making the selections in Figure 3.5.

[5] This action collapses the role/sub-role/activity hierarchy when a role is not selected.

Figure 3.4
Overview Dashboard Hide Action

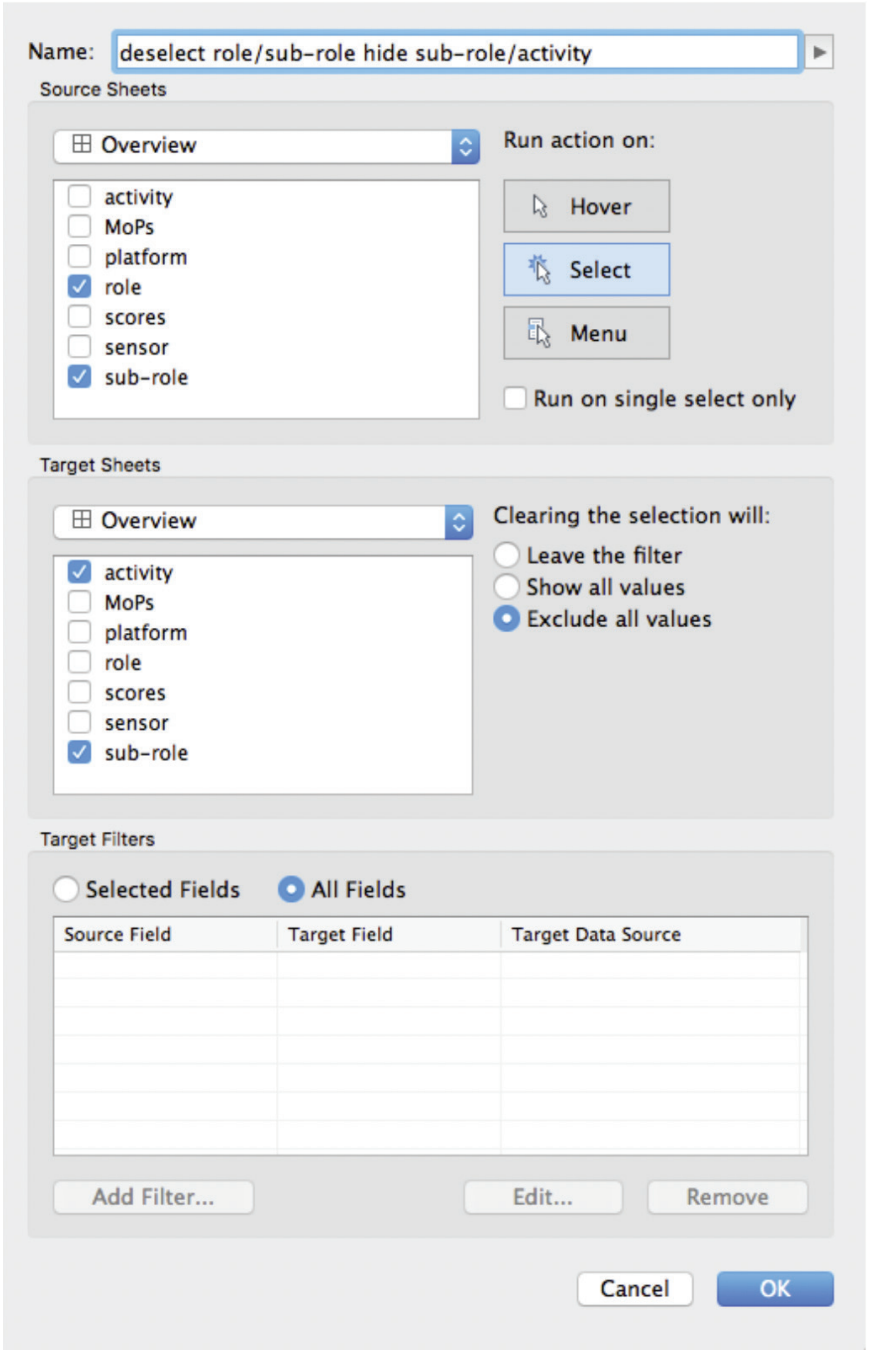
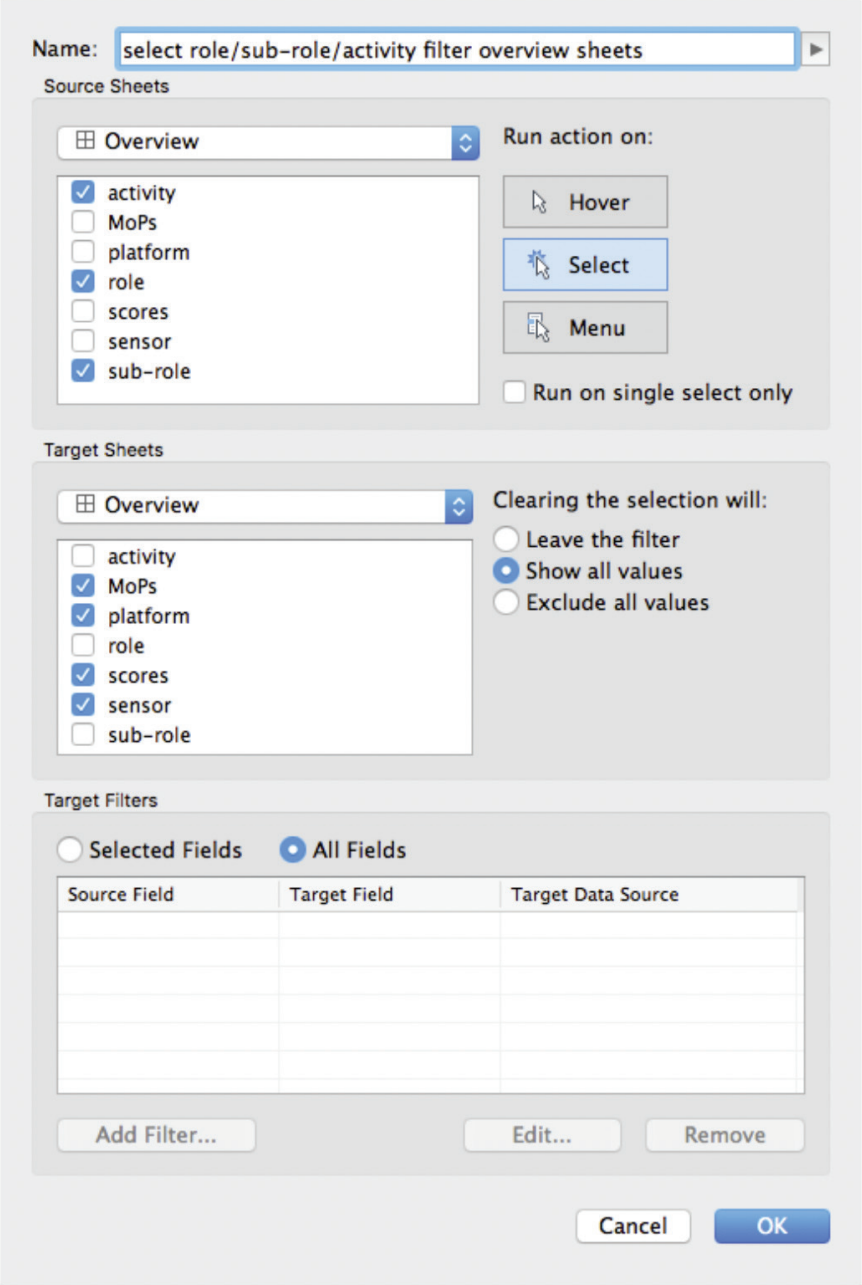


Figure 3.5
Overview Dashboard Filter Action



Map

Component Sheets

Follow the instructions below to construct each of the sheets in the Map dashboard:

Map View

1. Create a new sheet.

2. Assign Country to Detail on the Marks card.[6]
3. Assign AVG(System MoP) to Color on the Marks card.
4. Place a second Longitude on the Columns shelf next to the first.
5. Right click the second Longitude and select "Dual Axis."
6. On the second Longitude drop down on the Marks card, assign CNT(Number of Sorties) to Size.
7. On the second Longitude drop down on the Marks card, expand Country by clicking on the plus sign. Region will appear.
8. Add Missing Data to the Filters card. Select "False."

Map Role[7]

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Role to Label on the Marks card.
6. Add Date to the Filters card. Select "Range of Dates."
7. Add Missing Data to the Filters card. Select "False."
8. Add AVG(System MoP), Platform, Sensor, Operation, Country, Region to the Filters card. Select "Use all" for each.

Map Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Sub-role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Map Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.

---

[6] If the Country and Region fields are not given the correct Geographic Role ("Country/Region") or if the name of the location is ambiguous, the locations may not automatically populate, and the user will see an "X unknown" message at the bottom right corner of the screen. These unknowns can be manually corrected by clicking on this message→Edit Locations… and entering the correct latitude and longitude in the "Matching Location" column.

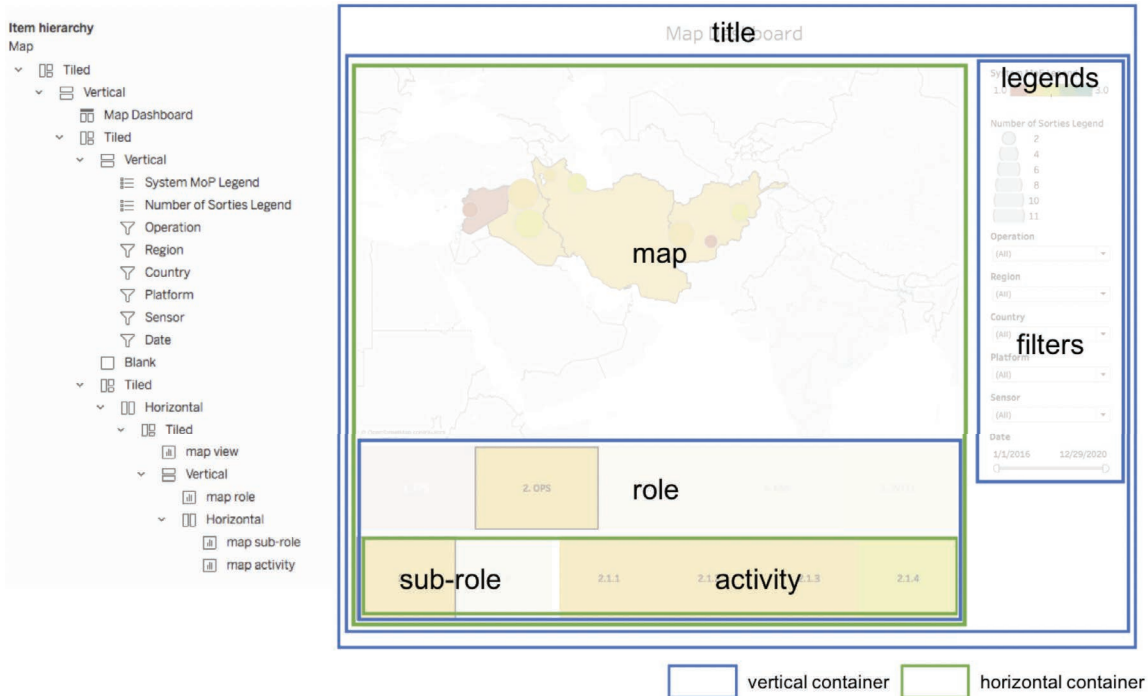
[7] The instructions for the sheets "map role," "map sub-role," and "map activity" are identical to those for "role," "sub-role," and "activity" described above. New sheets must be created for each dashboard so that actions taken on one dashboard do not affect the other dashboards. These instructions will be repeated as appropriate in later sections. A faster and easier alternative is to simply duplicate the sheet of interest and then make any necessary modifications.

5. Assign Activity to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Activity to the Filters card. Exclude null values.

Map Dashboard Assembly

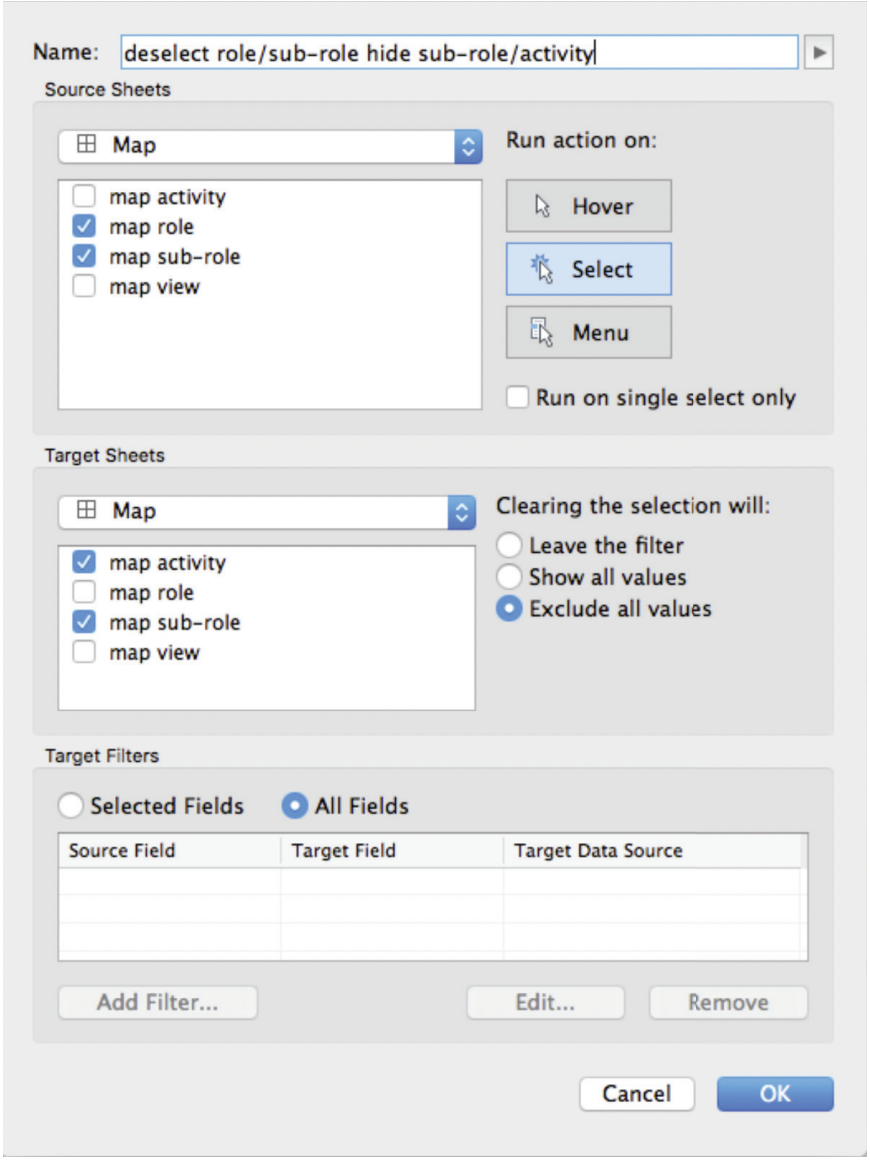
1. Create a new dashboard.
2. Place horizontal and vertical containers as depicted in Figure 3.6.

Figure 3.6
Layout of Map Dashboard



3. Add sheets as indicated in Figure 3.6.
4. Add the System MoP Legend, Number of Sorties Legend by selecting the down arrow→Legend→Color Legend (Avg. System MoP), Size Legend (Count of Number of Sorties) from any of the dashboard sheets.
5. Add the following filters by selecting the down arrow→Filters from the map role sheet on the dashboard: Operation, Region, Country, Platform, Sensor, Date.
6. For all filters, select the down arrow→Apply to Worksheets→Selected Worksheets→All on dashboard.
7. From the menu bar, select Dashboard→Actions...
8. Create action "deselect role/sub-role hide sub-role/activity" by making the selections in Figure 3.7.

Figure 3.7
Map Dashboard Hide Action



a. Create action "select country filter role/sub-role/activity" by making the selections in Figure 3.8.
b. Create action "select region filter role/sub-role/activity" by making the selections in Figure 3.9.
c. Create action "select role filter map" by making the selections in Figure 3.10.

Figure 3.8
Map Dashboard Country Filter Action

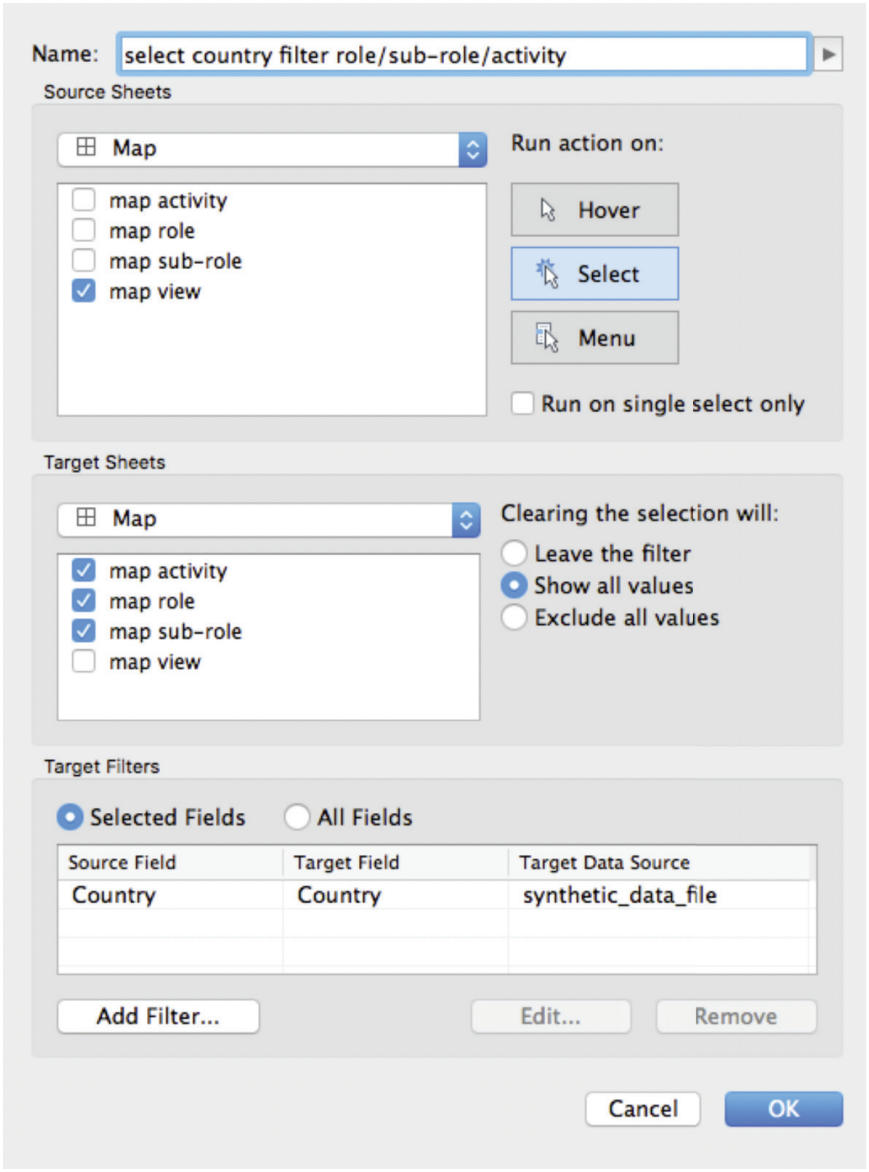


Figure 3.9
Map Dashboard Region Filter Action

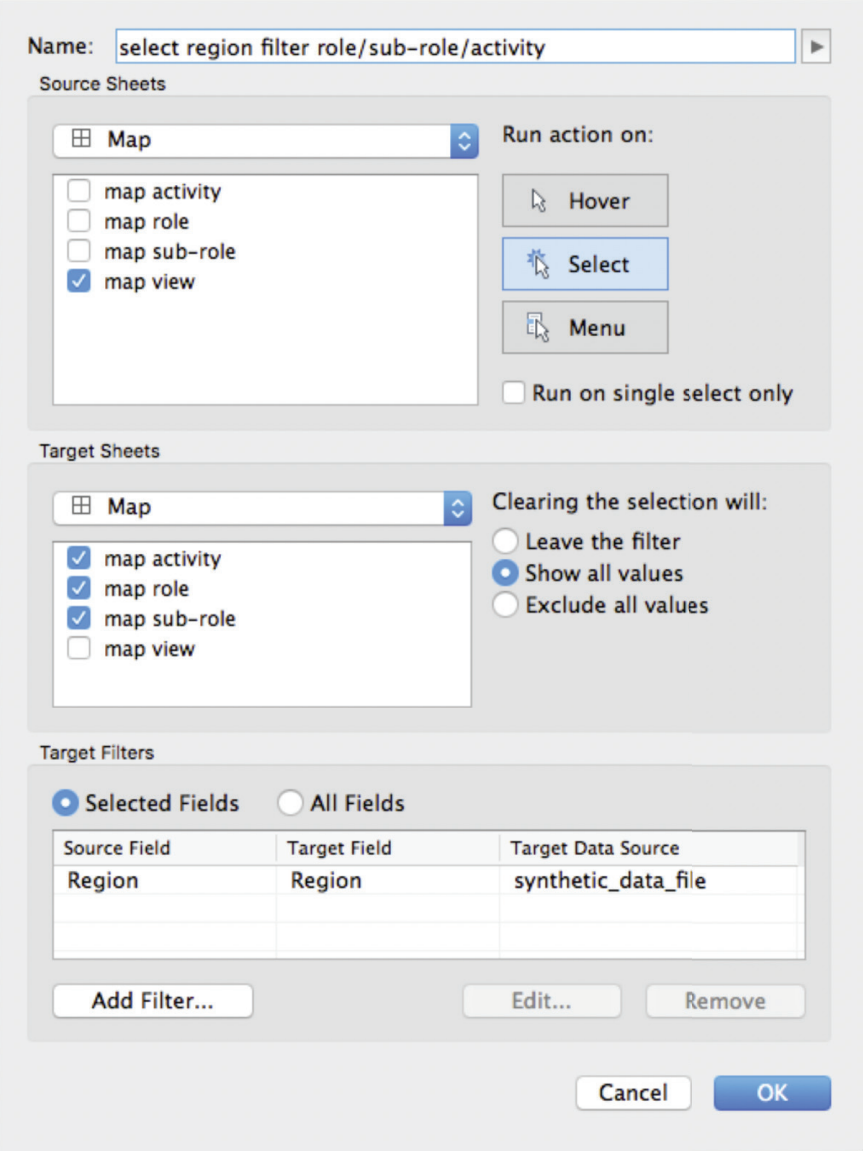
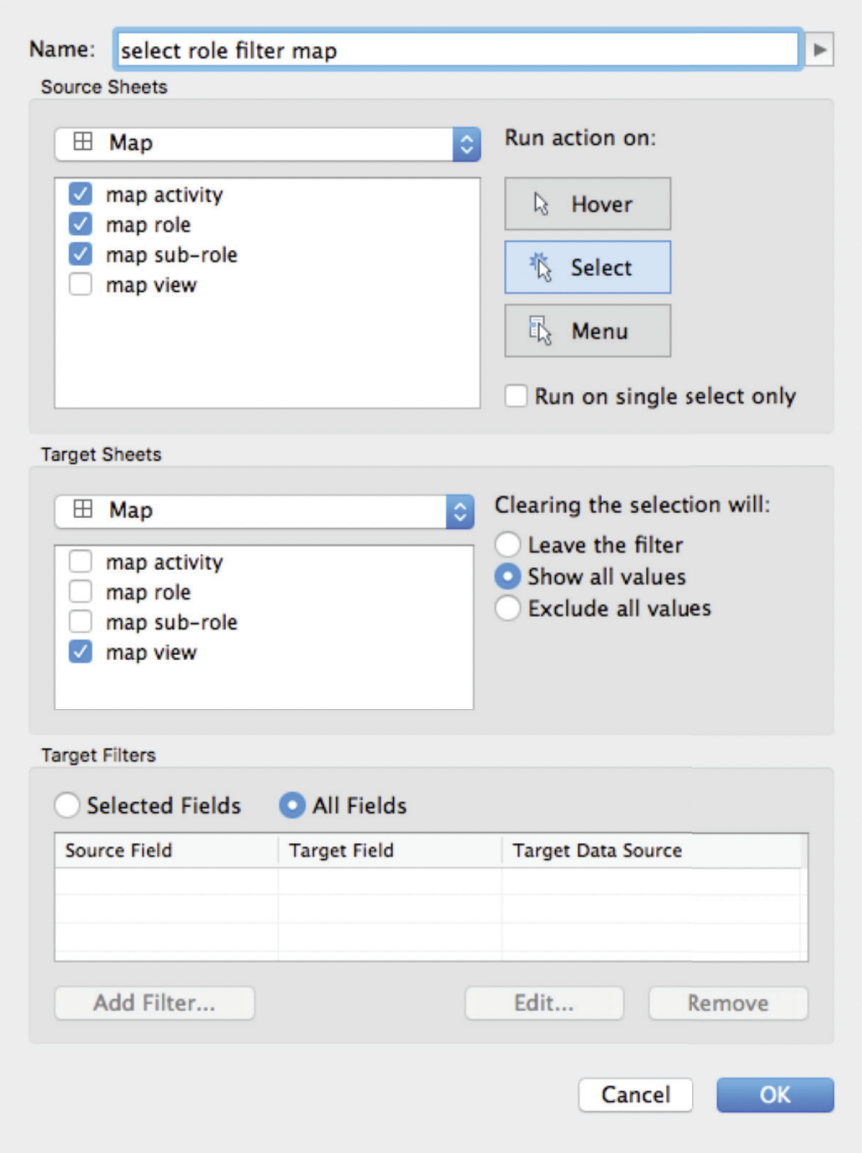


Figure 3.10
Map Dashboard Map Filter Action



Platform Comparison

Component Sheets

Follow the instructions below to construct each of the sheets in the Platform Comparison dashboard:

Platform1 Role

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.

5. Assign Role to Label on the Marks card.
6. Add Date to the Filters card. Select "Range of Dates."
7. Add Missing Data to the Filters card. Select "False."
8. Add AVG(System MoP), Platform, Sensor, Operation, Country, Region to the Filters card. Select "Use all" for each.

Platform1 Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Sub-role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Platform1 Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Activity to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Activity to the Filters card. Exclude null values.

Platform1 Sensor

1. Create a new sheet.
2. Place Sensor on the Rows shelf.
3. Set Marks card to Shape (triangles).
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign AVG(System MoP) to Tooltip on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Platform1 Scores

1. Create a new sheet.
2. Place Measure Names on the Rows shelf.
3. Add Measure Names to the Filters card. Select "Aircraft Score, Collection Score, Tasking Score."
4. Set Marks card to Shape (squares).
5. Assign Measure Values to Color on the Marks Card. Click on the down arrow to set the measure to "Average."
6. Add Missing Data to the Filters card. Select "False."

Platform2 Role

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Platform to the Filters card. Select "Use all."

Platform2 Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Sub-role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Platform2 Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Activity to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Activity to the Filters card. Exclude null values.

Platform2 Sensor

1. Create a new sheet.
2. Place Sensor on the Rows shelf.
3. Set Marks card to Shape (triangles).
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign AVG(System MoP) to Tooltip on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Platform2 Scores

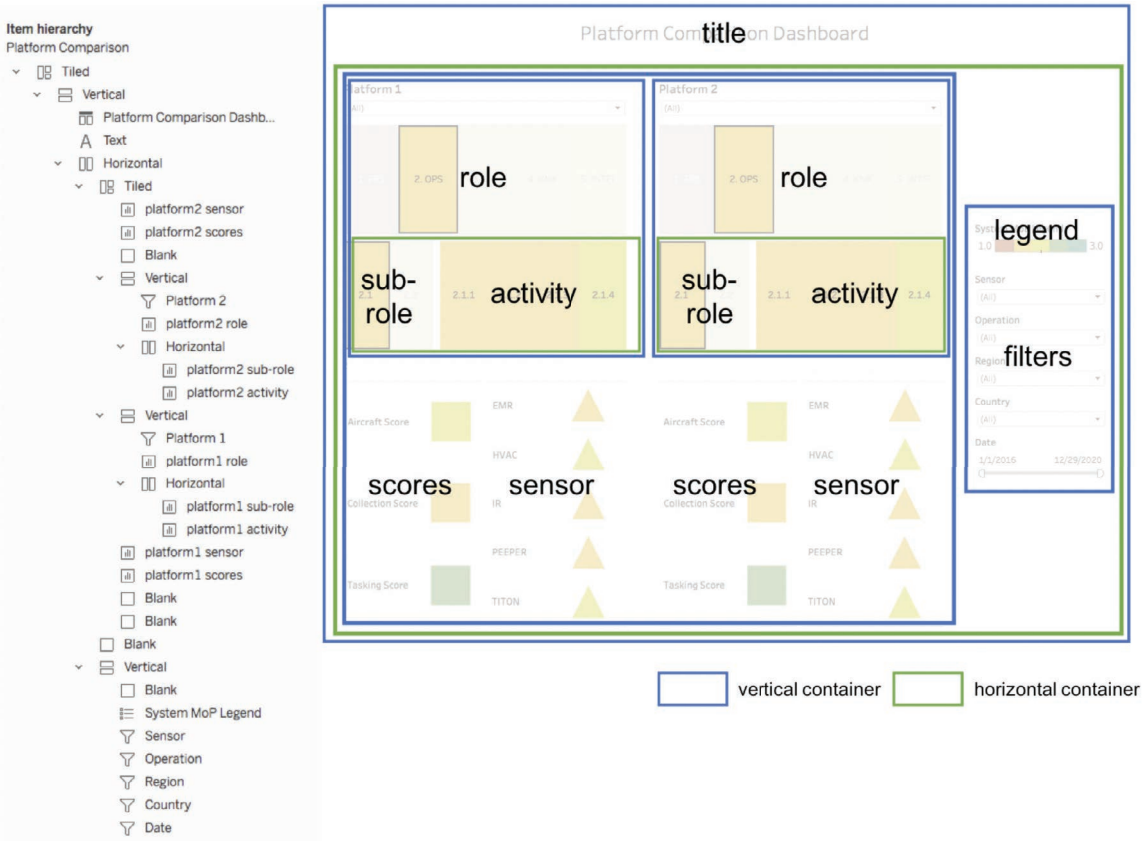
1. Create a new sheet.
2. Place Measure Names on the Rows shelf.
3. Add Measure Names to the Filters card. Select "Aircraft Score, Collection Score, Tasking Score."
4. Set Marks card to Shape (squares).

5. Assign Measure Values to Color on the Marks Card. Click on the down arrow to set the measure to "Average."
6. Add Missing Data to the Filters card. Select "False."

Platform Comparison Dashboard Assembly

1. Create a new dashboard.
2. Place horizontal and vertical containers as depicted in Figure 3.11.

Figure 3.11
Layout of Platform Comparison Dashboard



3. Add sheets as indicated in Figure 3.11.
4. Add the System MoP Legend by selecting the down arrow→Legend→Color Legend (Avg. System MoP) from any of the dashboard sheets.
5. Add the following filters by selecting the down arrow→Filters from the platform1 role and platform2 role sheets on the dashboard: Platform (from platform1 role), Platform (from platform2 role), Sensor, Operation, Region, Country, Date.
6. For all filters except for the Platform filters, select the down arrow→Apply to Worksheets→Selected Worksheets→All on dashboard.

7. For the platform1 role Platform filter, select the down arrow→Apply to Worksheets→Selected Worksheets→all platform1 sheets.
8. For the platform2 role Platform filter, select the down arrow→Apply to Worksheets→Selected Worksheets→all platform2 sheets.
9. From the menu bar, select Dashboard→Actions...
    a. Create action "deselect platform1 role/sub-role hide sub-role/activity" by making the selections in Figure 3.12.
    b. Create action "deselect platform2 role/sub-role hide sub-role/activity" by making the selections in Figure 3.13.
    c. Create action "select platform1 role/sub-role/activity filter platform1 sheets" by making the selections in Figure 3.14.
    d. Create action "select platform2 role/sub-role filter platform2 sheets" by making the selections in Figure 3.15.

Figure 3.12
Platform Comparison Dashboard Platform1 Hide Action

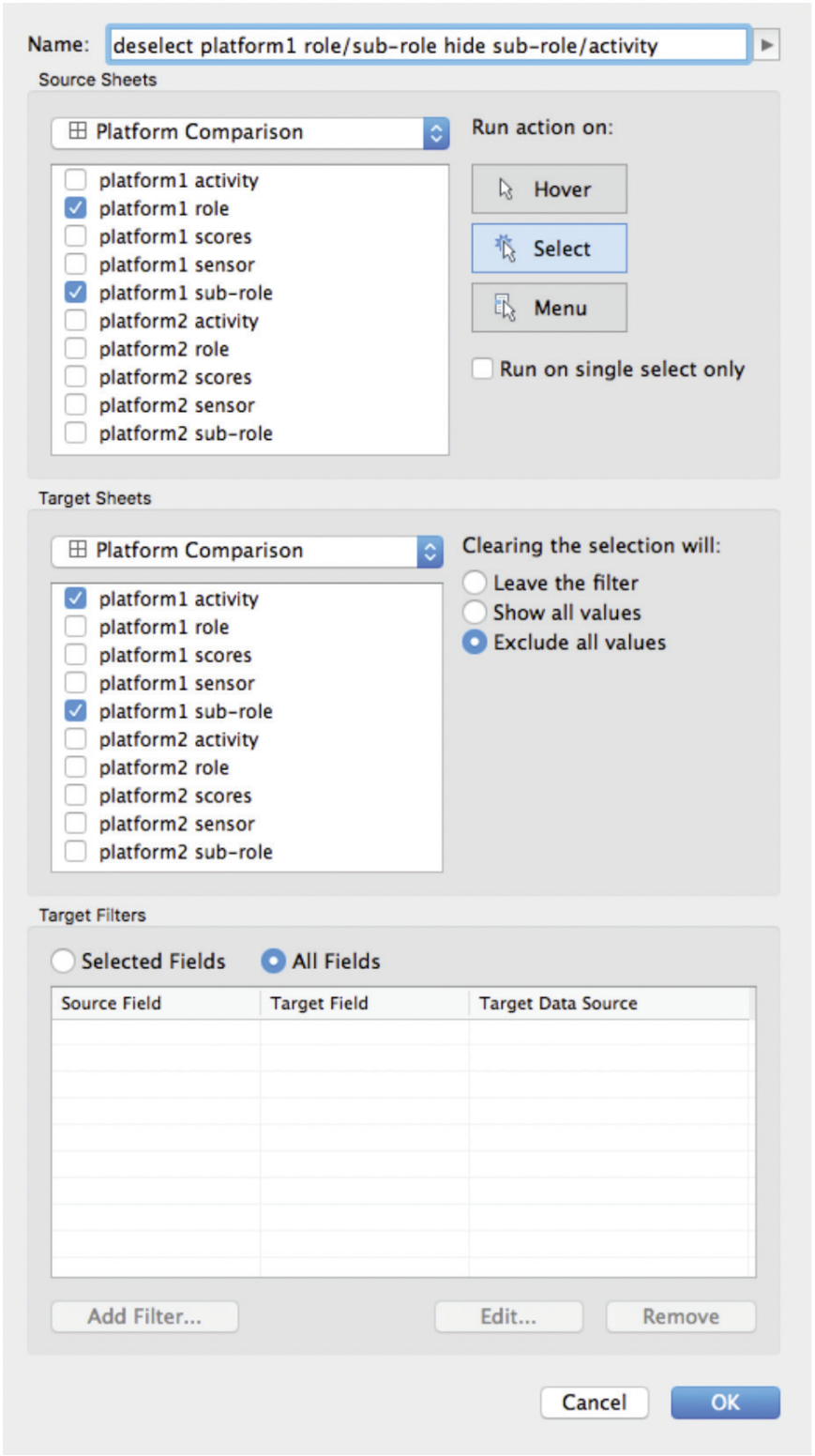


Figure 3.13
Platform Comparison Dashboard Platform2 Hide Action

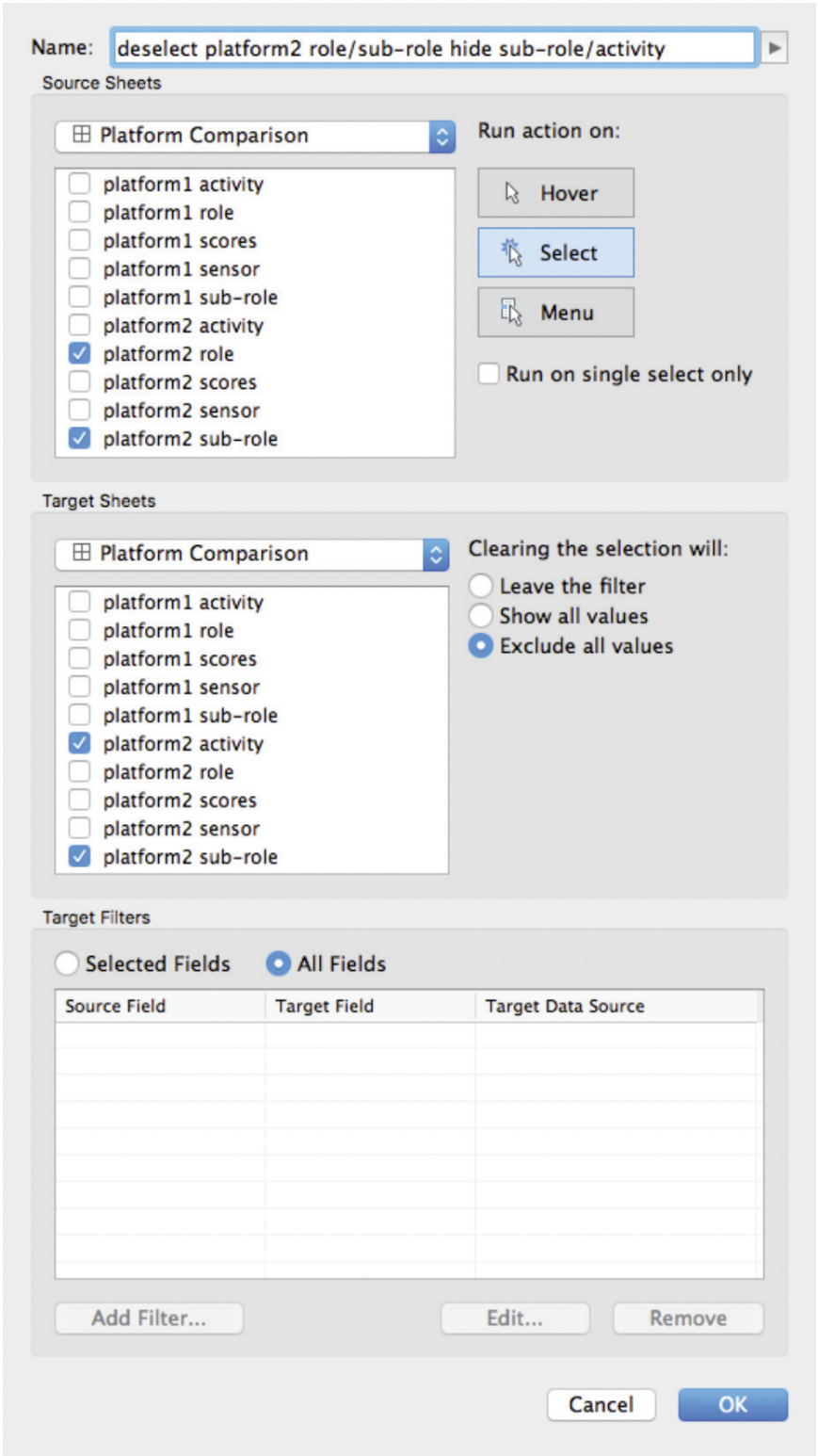


Figure 3.14
Platform Comparison Dashboard Platform1 Filter Action

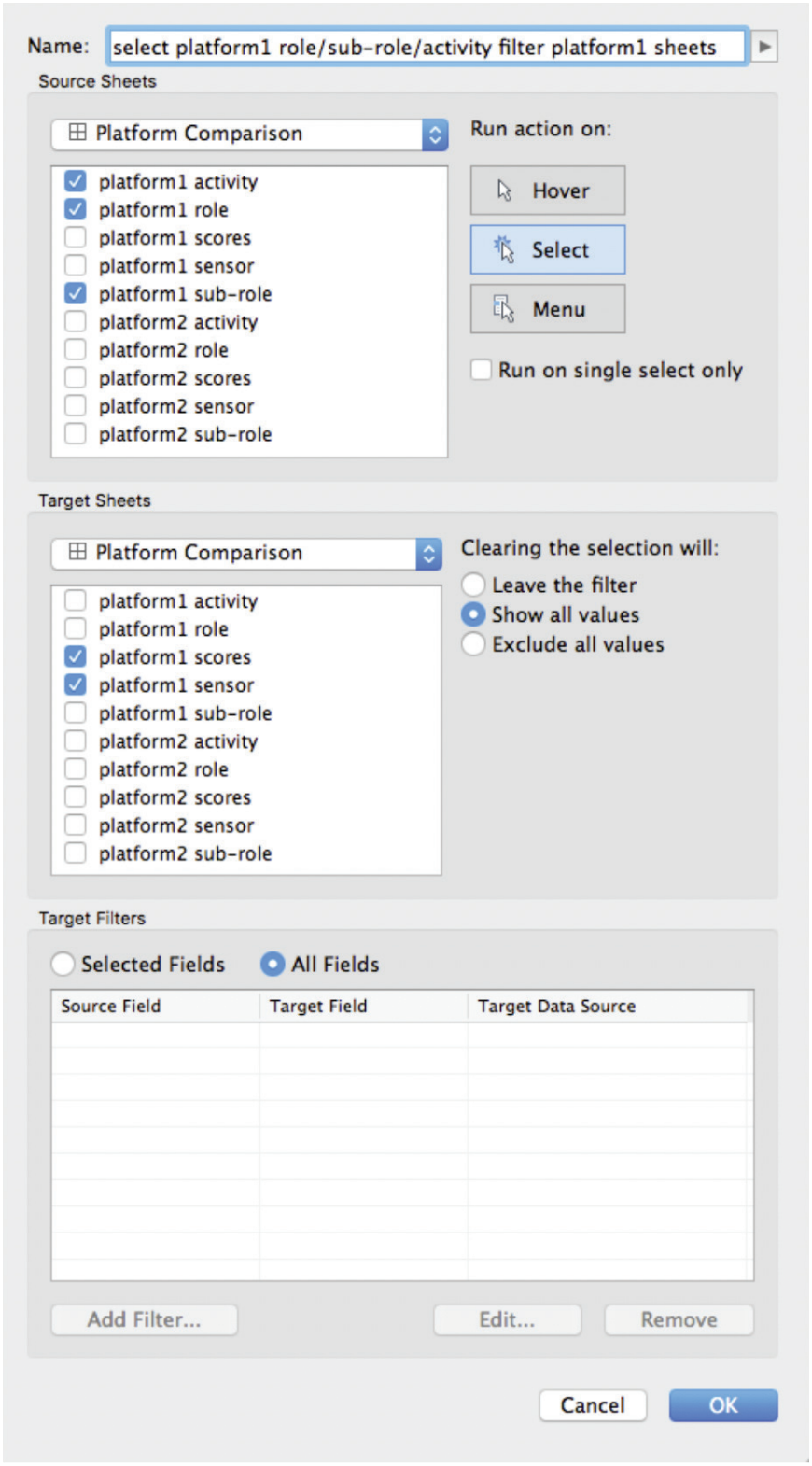
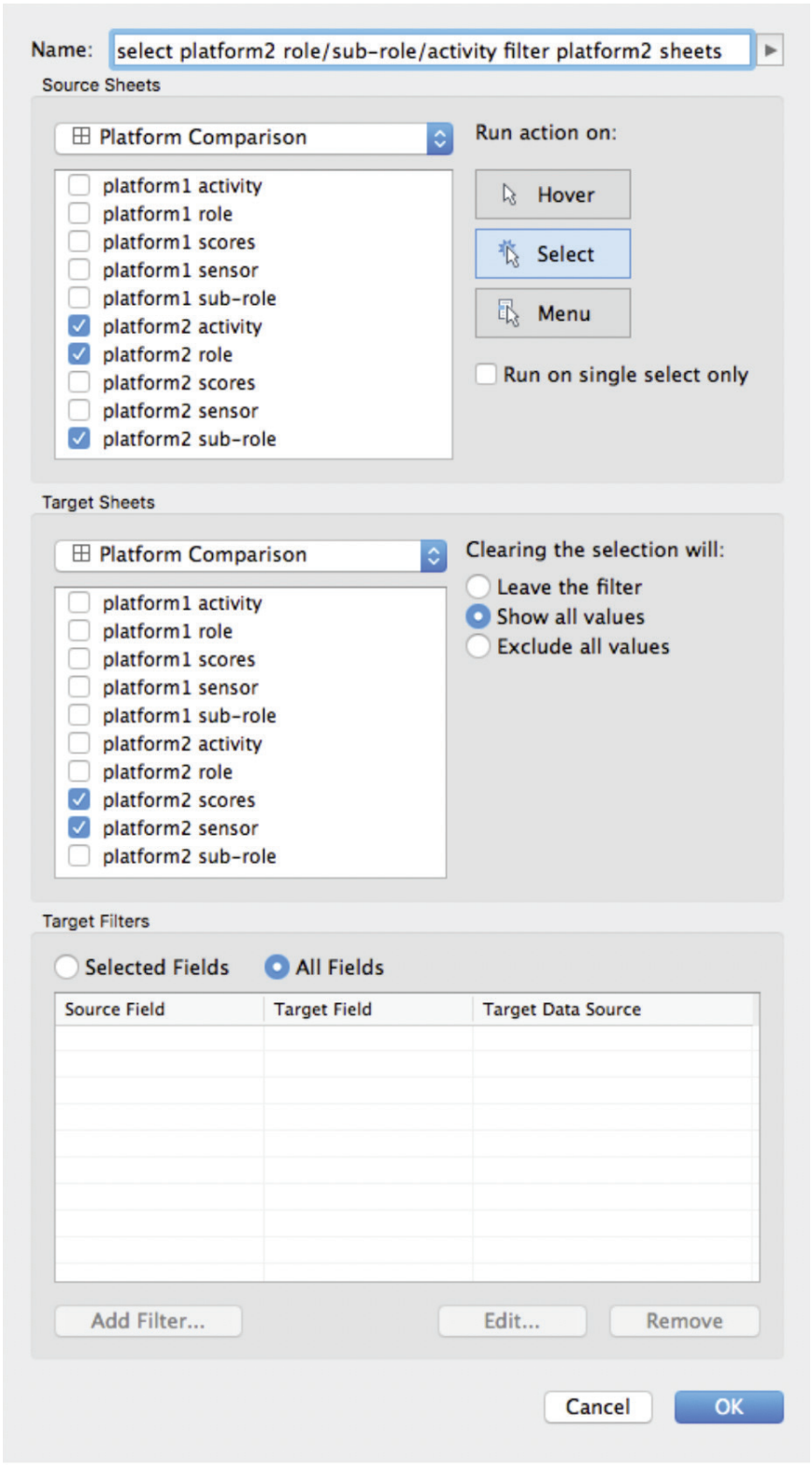


Figure 3.15
Platform Comparison Dashboard Platform2 Filter Action



Sensor Comparison

Component Sheets

Follow the instructions below to construct each of the sheets in the Sensor Comparison dashboard:

Sensor1 Role

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Role to Label on the Marks card.
6. Add Date to the Filters card. Select "Range of Dates."
7. Add Missing Data to the Filters card. Select "False."
8. Add AVG(System MoP), Platform, Sensor, Operation, Country, Region to the Filters card. Select "Use all" for each.

Sensor1 Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Sub-role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Sensor1 Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Activity to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Activity to the Filters card. Exclude null values.

Sensor1 Platform

1. Create a new sheet.
2. Place Platform on the Rows shelf.
3. Set Marks card to Shape (circles).
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign AVG(System MoP) to Tooltip on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Sensor1 Scores

1. Create a new sheet.
2. Place Measure Names on the Rows shelf.
3. Add Measure Names to the Filters card. Select "Aircraft Score, Collection Score, Tasking Score."
4. Set Marks card to Shape (squares).
5. Assign Measure Values to Color on the Marks Card. Click on the down arrow to set the measure to "Average."
6. Add Missing Data to the Filters card. Select "False."

Sensor2 Role

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Sensor to the Filters card. Select "Use all."

Sensor2 Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Sub-role to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

Sensor2 Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign Activity to Label on the Marks card.
6. Add Missing Data to the Filters card. Select "False."
7. Add Activity to the Filters card. Exclude null values.

Sensor2 Platform

1. Create a new sheet.
2. Place Platform on the Rows shelf.

3. Set Marks card to Shape (circles).
4. Assign AVG(System MoP) to Color on the Marks card.
5. Assign AVG(System MoP) to Tooltip on the Marks card.
6. Add Missing Data to the Filters card. Select "False."

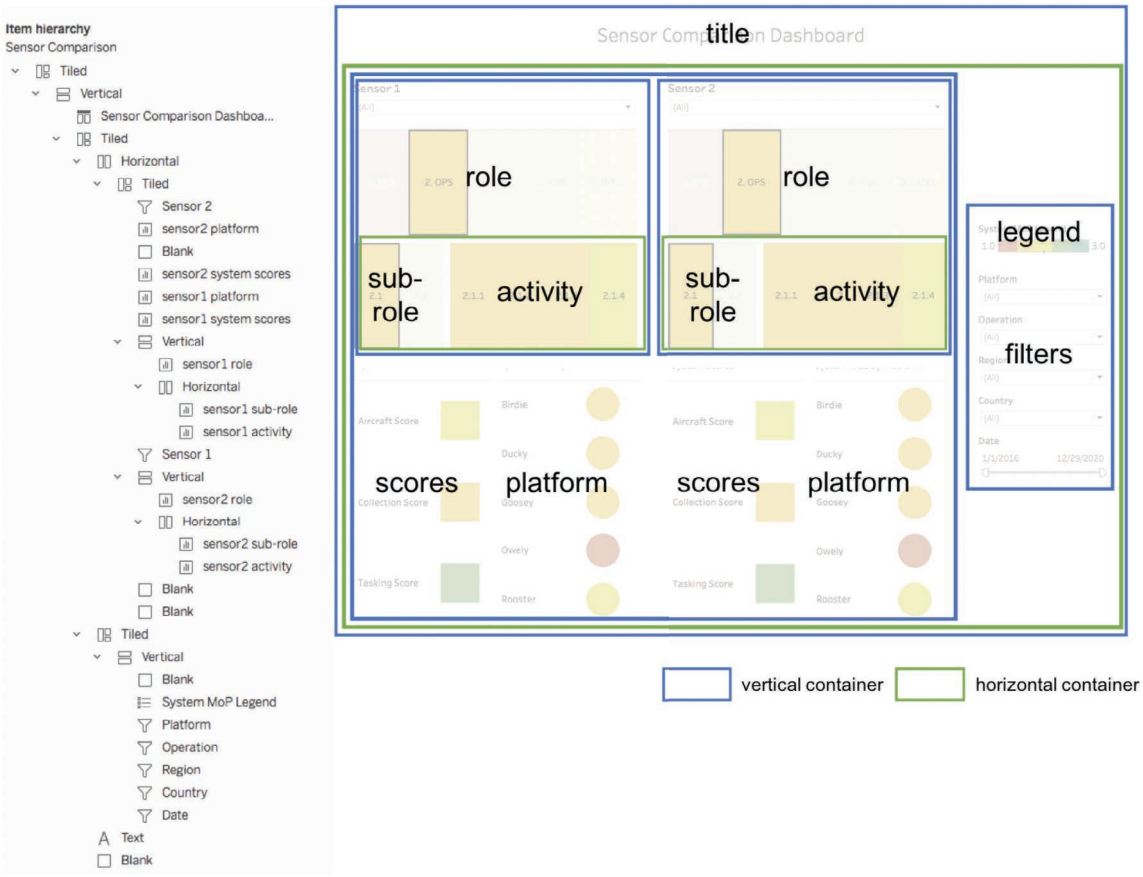
Sensor2 Scores

1. Create a new sheet.
2. Place Measure Names on the Rows shelf.
3. Add Measure Names to the Filters card. Select "Aircraft Score, Collection Score, Tasking Score."
4. Set Marks card to Shape (squares).
5. Assign Measure Values to Color on the Marks Card. Click on the down arrow to set the measure to "Average."
6. Add Missing Data to the Filters card. Select "False."

Sensor Comparison Dashboard Assembly

1. Create a new dashboard.
2. Place horizontal and vertical containers as depicted in Figure 3.16.

Figure 3.16
Layout of Sensor Comparison Dashboard



3. Add sheets as indicated in Figure 3.16.
4. Add the System MoP Legend by selecting the down arrow→Legend→Color Legend (Avg. System MoP) from any of the dashboard sheets.
5. Add the following filters by selecting the down arrow→Filters from the sensor1 role and sensor2 role sheets on the dashboard: Sensor (from sensor1 role), Sensor (from sensor2 role), Platform, Operation, Region, Country, Date.
6. For all filters, select the down arrow→Apply to Worksheets→Selected Worksheets→All on dashboard.
7. For the sensor1 role Sensor filter, select the down arrow→Apply to Worksheets→Selected Worksheets→all sensor1 sheets.
8. For the sensor2 role Sensor filter, select the down arrow→Apply to Worksheets→Selected Worksheets→all sensor2 sheets.
9. From the menu bar, select Dashboard→Actions...
    a. Create action "deselect sensor1 role/sub-role hide sub-role/activity" by making the selections in Figure 3.17.
    b. Create action "deselect sensor2 role/sub-role hide sub-role/activity" by making the selections in Figure 3.18.
    c. Create action "select sensor1 role/sub-role/activity filter sensor1 sheets" by making the selections in Figure 3.19.
    d. Create action "select sensor2 role/sub-role filter sensor2 sheets" by making the selections in Figure 3.20.

Figure 3.17
Sensor Comparison Dashboard Sensor1 Hide Action

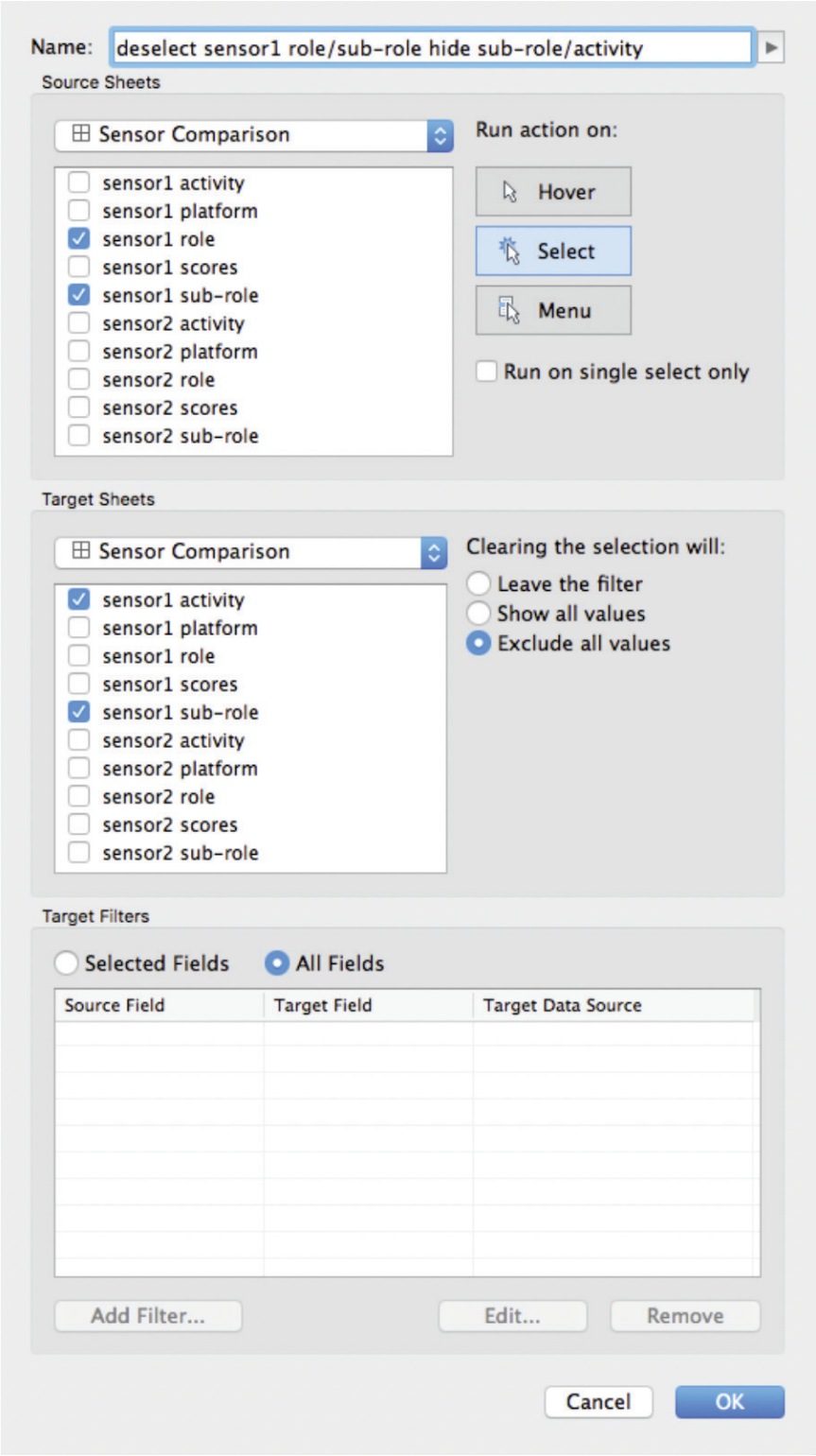


Figure 3.18
Sensor Comparison Dashboard Sensor2 Hide Action

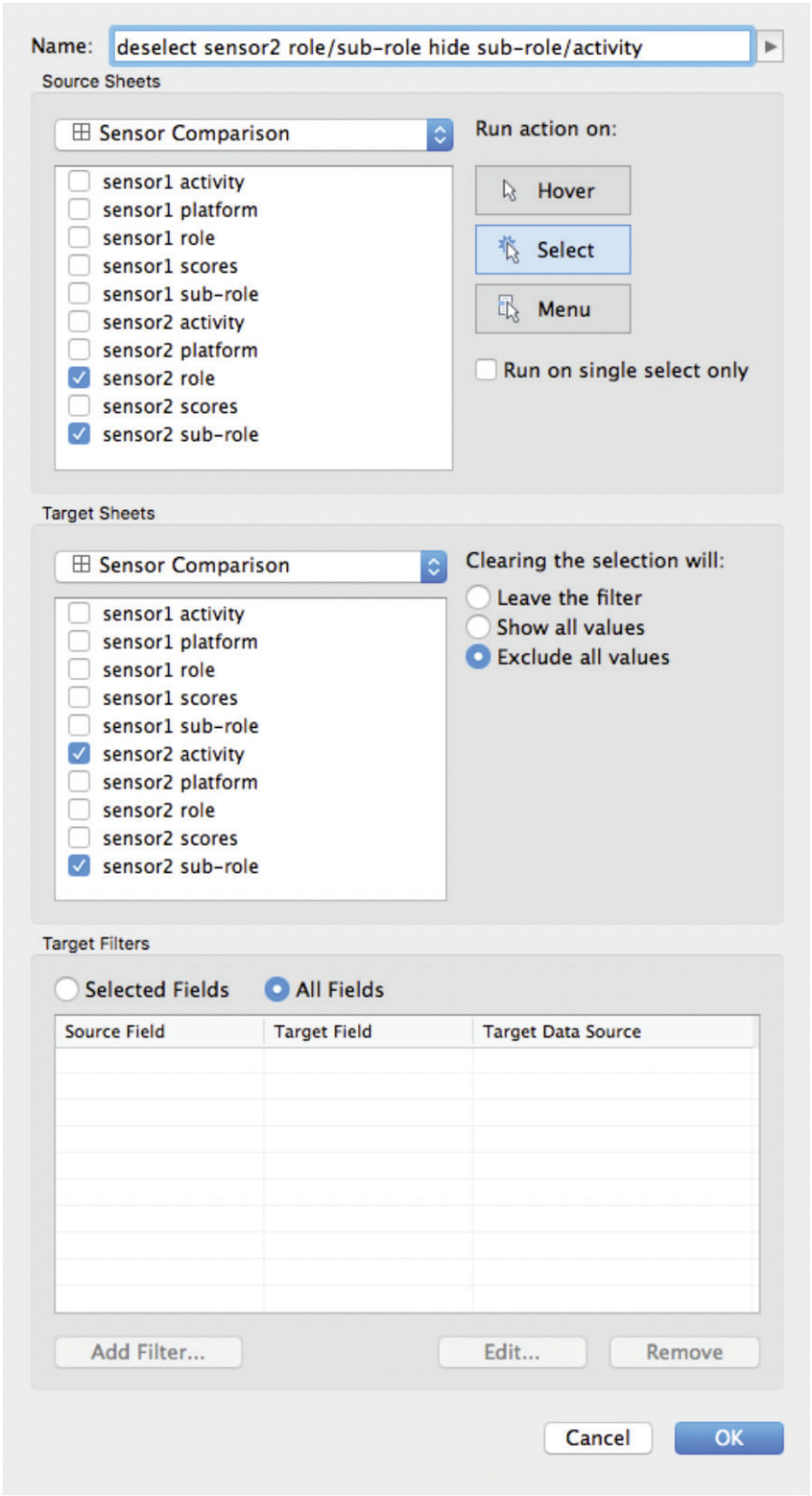


Figure 3.19
Sensor Comparison Dashboard Sensor1 Filter Action

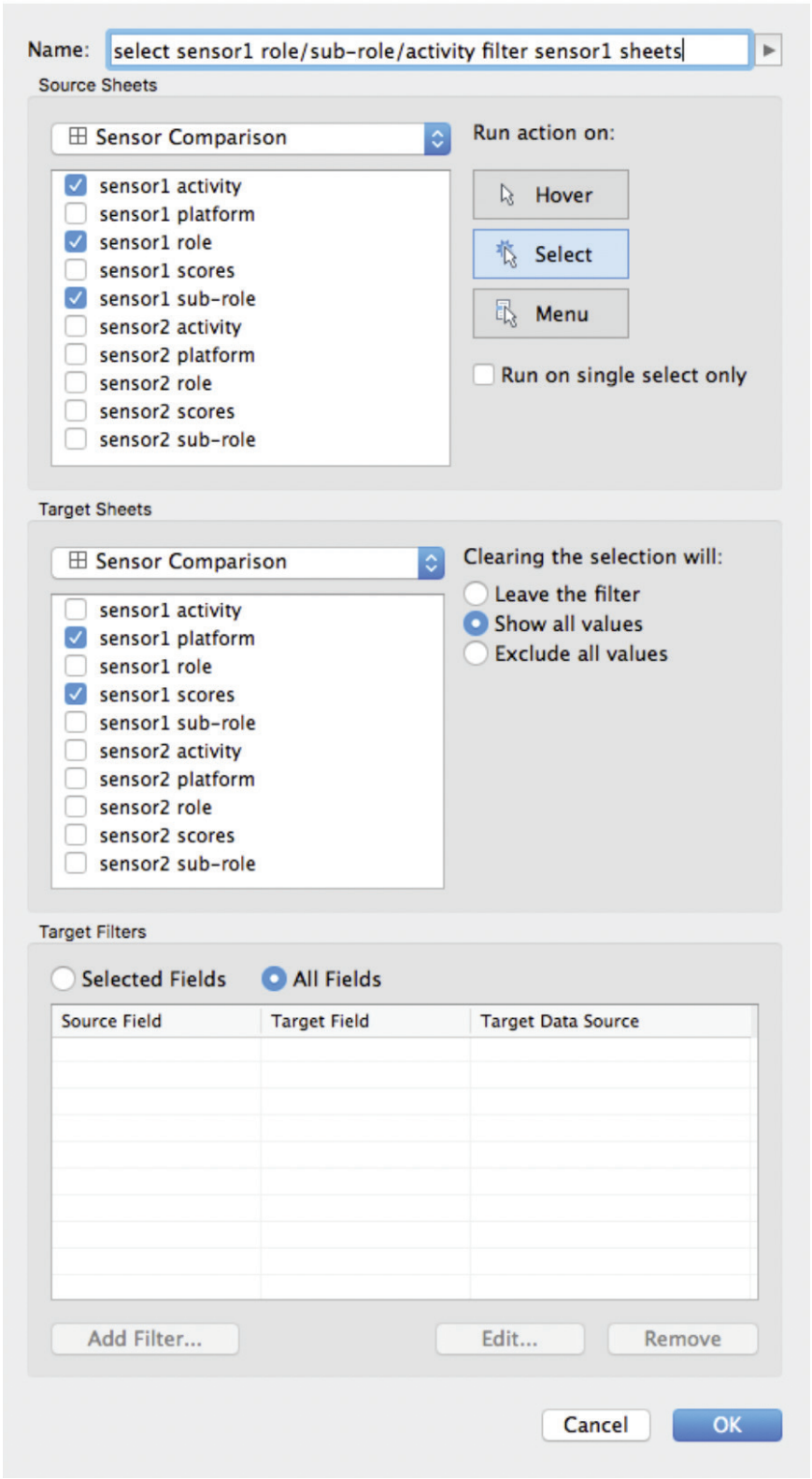
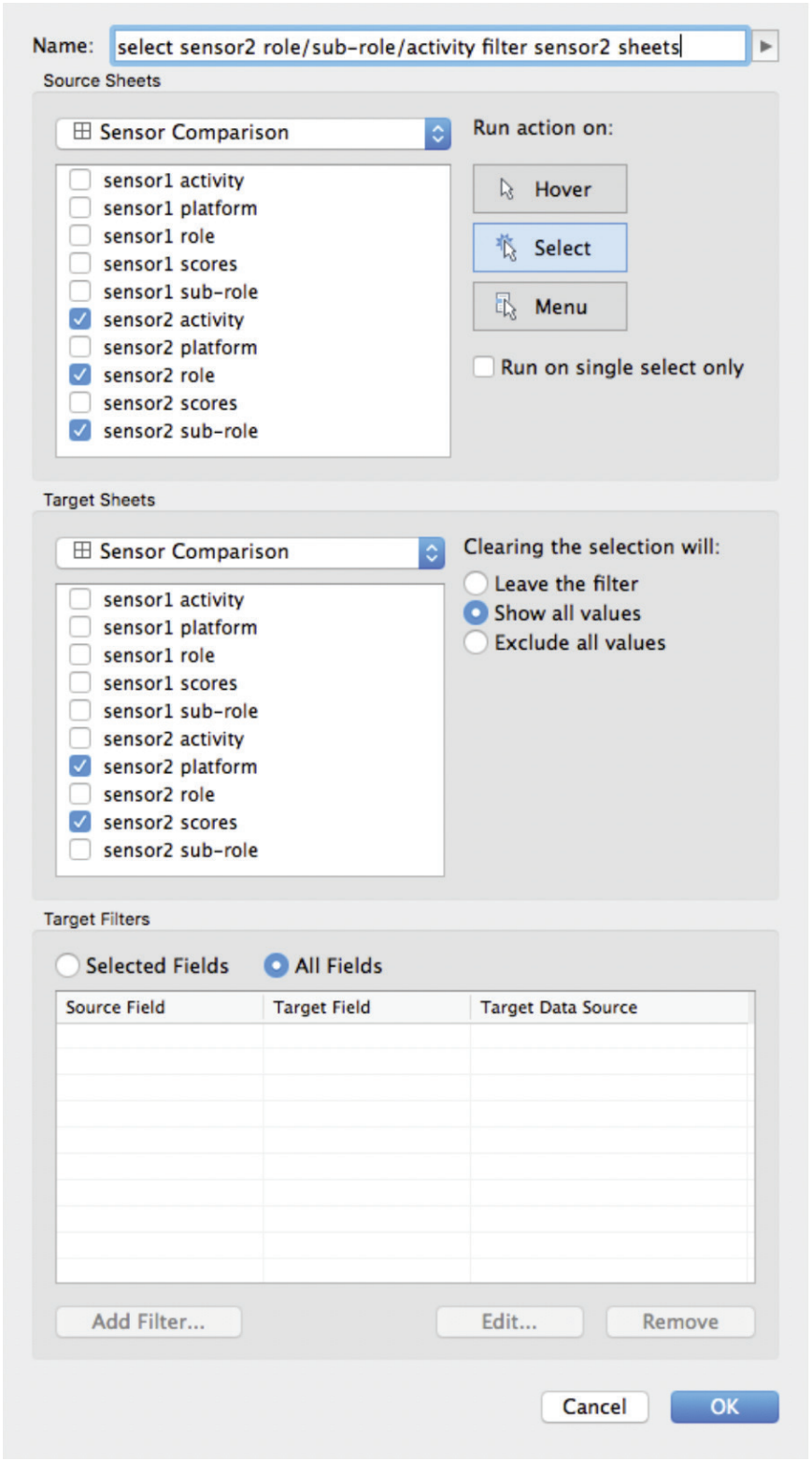


Figure 3.20
Sensor Comparison Dashboard Sensor2 Filter Action



Missing Data

Component Sheets

Follow the instructions below to construct each of the sheets in the Missing Data dashboard:

Missing Data Map

1. Create a new sheet.
2. Assign Country to Detail on the Marks card.
3. Assign SUM(Missing Records) to Tooltip on the Marks card.
4. Place a second Longitude on the Columns shelf next to the first.
5. Right-click the second Longitude and select "Dual Axis."
6. On the first Longitude drop down on the Marks card, assign AVG(Missing Data Percentage) to Color.
7. On the first Longitude drop down on the Marks card, assign CNT(Number of Sorties) to Tooltip.
8. On the second Longitude drop down on the Marks card, assign CNT(Number of Sorties) to Size.
9. On the second Longitude drop down on the Marks card, assign AVG(Missing Data Percentage) to Tooltip.
10. On the second Longitude drop down on the Marks card, expand Country by clicking on the plus sign. Region will appear.

Missing Data Role

1. Create a new sheet.
2. Place Role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(Missing Data Percentage) to Color on the Marks card.
5. Assign SUM(Missing Records) to Tooltip on the Marks card.
6. Assign CNT(Number of Sorties) to Tooltip on the Marks card.
7. Edit Tooltip to state:
   Percentage of Sorties Missing Data: <AVG(Missing Data Percentage)>%
   Number of Sorties Missing Data: <SUM(Missing Records)>
   Total Number of Sorties: <CNT(Number of Sorties)>
8. Assign Role to Label on the Marks card.
9. Add Date to the Filters card. Select "Range of Dates."
10. Add AVG(Missing Data Percentage), Platform, Sensor, Operation, Country, Region, Missing Data to the Filters card. Select "Use all" for each.

Missing Data Sub-role

1. Create a new sheet.
2. Place Sub-role on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(Missing Data Percentage) to Color on the Marks card.

5. Assign SUM(Missing Records) to Tooltip on the Marks card.
6. Assign CNT(Number of Sorties) to Tooltip on the Marks card.
7. Edit Tooltip to state:
   Percentage of Sorties Missing Data: <AVG(Missing Data Percentage)>%
   Number of Sorties Missing Data: <SUM(Missing Records)>
   Total Number of Sorties: <CNT(Number of Sorties)>
8. Assign Sub-role to Label on the Marks card.

Missing Data Activity

1. Create a new sheet.
2. Place Activity on the Columns shelf.
3. Set Marks card to Square.
4. Assign AVG(Missing Data Percentage) to Color on the Marks card.
5. Assign SUM(Missing Records) to Tooltip on the Marks card.
6. Assign CNT(Number of Sorties) to Tooltip on the Marks card.
7. Edit Tooltip to state:
   Percentage of Sorties Missing Data: <AVG(Missing Data Percentage)>%
   Number of Sorties Missing Data: <SUM(Missing Records)>
   Total Number of Sorties: <CNT(Number of Sorties)>
8. Assign Activity to Label on the Marks card.
9. Add Activity to the Filters card. Exclude null values.

Missing Data Operation

1. Create a new sheet.
2. Place Operation on the Rows shelf.
3. Set Marks card to Square.
4. Assign AVG(Missing Data Percentage) to Color on the Marks card.
5. Assign SUM(Missing Records) to Tooltip on the Marks card.
6. Assign AVG(Missing Data Percentage) to Tooltip on the Marks card.
7. Edit Tooltip to state:
   Percentage of Sorties Missing Data: <AVG(Missing Data Percentage)>%
   Number of Sorties Missing Data: <SUM(Missing Records)>
8. Assign CNT(Number of Sorties) to Label on the Marks card.

Missing Data Platform

1. Create a new sheet.
2. Place Platform on the Rows shelf.
3. Set Marks card to Square.
4. Assign AVG(Missing Data Percentage) to Color on the Marks card.
5. Assign SUM(Missing Records) to Tooltip on the Marks card.
6. Assign AVG(Missing Data Percentage) to Tooltip on the Marks card.
7. Edit Tooltip to state:

Percentage of Sorties Missing Data: <AVG(Missing Data Percentage)>%
Number of Sorties Missing Data: <SUM(Missing Records)>

8. Assign CNT(Number of Sorties) to Label on the Marks card.

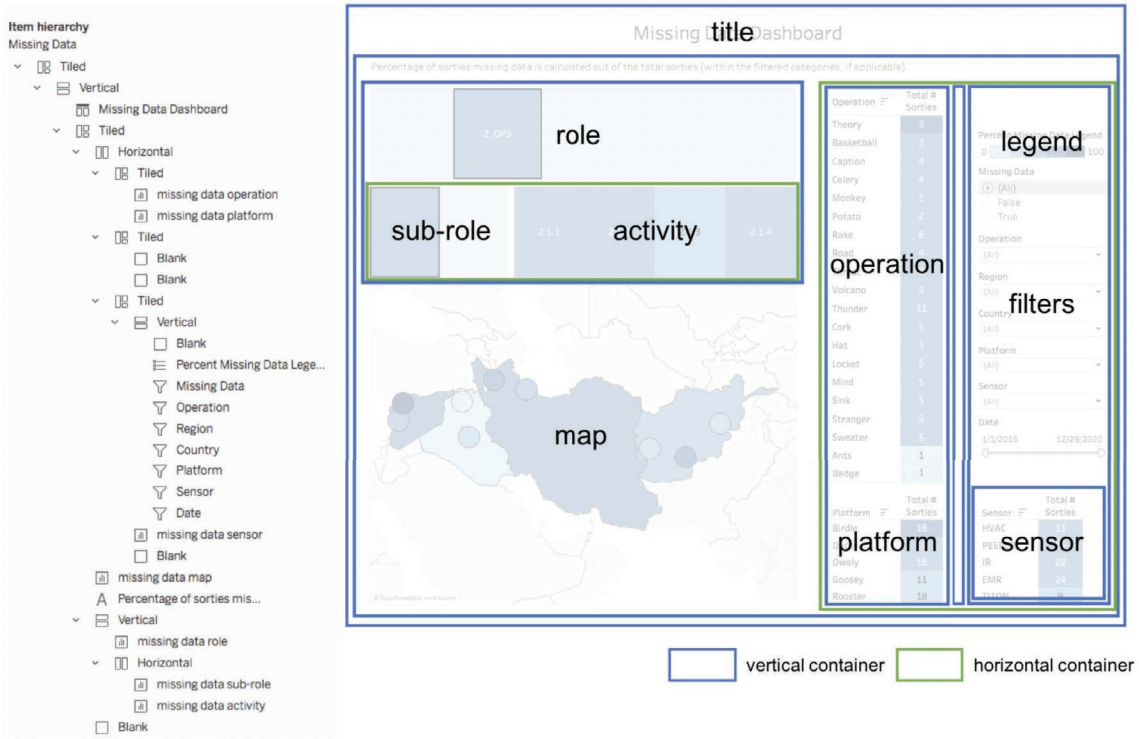
Missing Data Sensor

1. Create a new sheet.
2. Place Sensor on the Rows shelf.
3. Set Marks card to Square.
4. Assign AVG(Missing Data Percentage) to Color on the Marks card.
5. Assign SUM(Missing Records) to Tooltip on the Marks card.
6. Assign AVG(Missing Data Percentage) to Tooltip on the Marks card.
7. Edit Tooltip to state:
   Percentage of Sorties Missing Data: <AVG(Missing Data Percentage)>%
   Number of Sorties Missing Data: <SUM(Missing Records)>
8. Assign CNT(Number of Sorties) to Label on the Marks card.

Missing Data Dashboard Assembly

1. Create a new dashboard.
2. Place horizontal and vertical containers as depicted in Figure 3.21.

Figure 3.21
Layout of Missing Data Dashboard



3. Add sheets as indicated in Figure 3.21.
4. Add the Missing Data Percentage Legend by selecting the down arrow→Legend →Color Legend (Avg. Missing Data Percentage) from any of the dashboard sheets.
5. Add the following filters by selecting the down arrow→Filters from the missing data role sheet on the dashboard: Missing Data, Operation, Region, Country, Platform, Sensor, Date.
6. For all filters, select the down arrow→Apply to Worksheets→Selected Worksheets→All on dashboard.
7. From the menu bar, select Dashboard→Actions...
   a. Create action "deselect role/sub-role hide sub-role/activity" by making the selections in Figure 3.22.
   b. Create action "select map country filter sheets" by making the selections in Figure 3.23.
   c. Create action "select map region filter sheets" by making the selections in Figure 3.24.
   d. Create action "select role/sub-role/activity filter sheets" by making the selections in Figure 3.25.

Figure 3.22
Missing Data Dashboard Hide Action

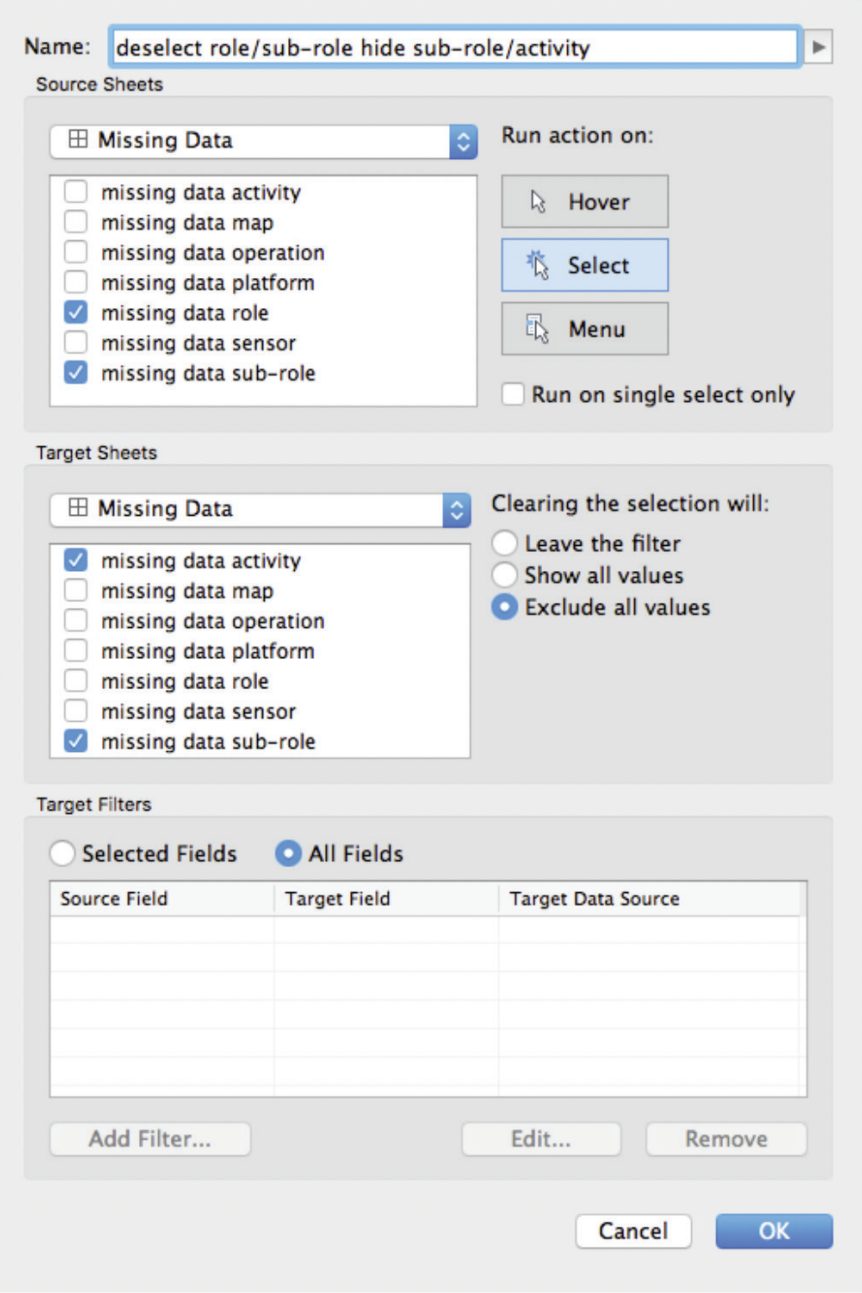


Figure 3.23
Missing Data Dashboard Country Filter Action

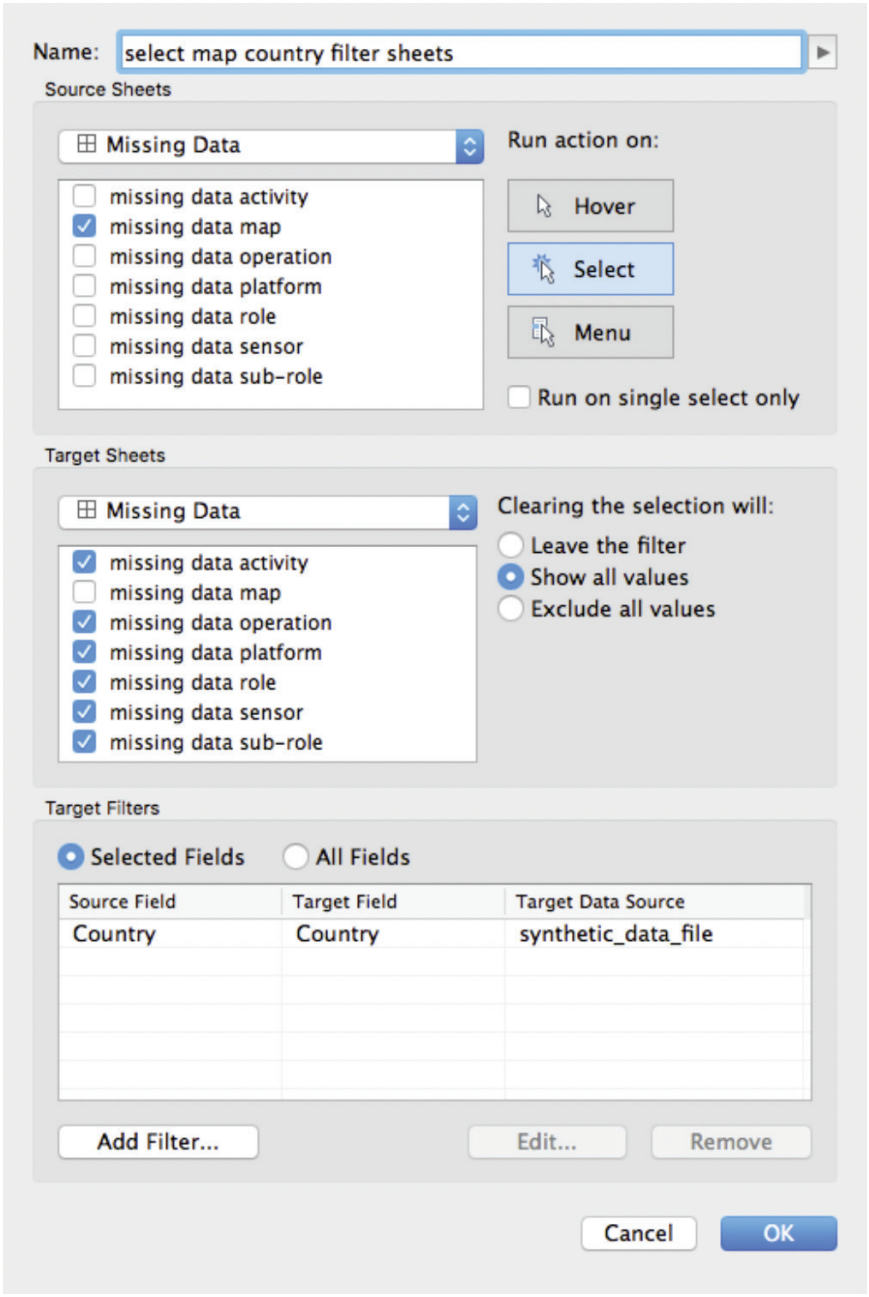


Figure 3.24
Missing Data Dashboard Region Filter Action

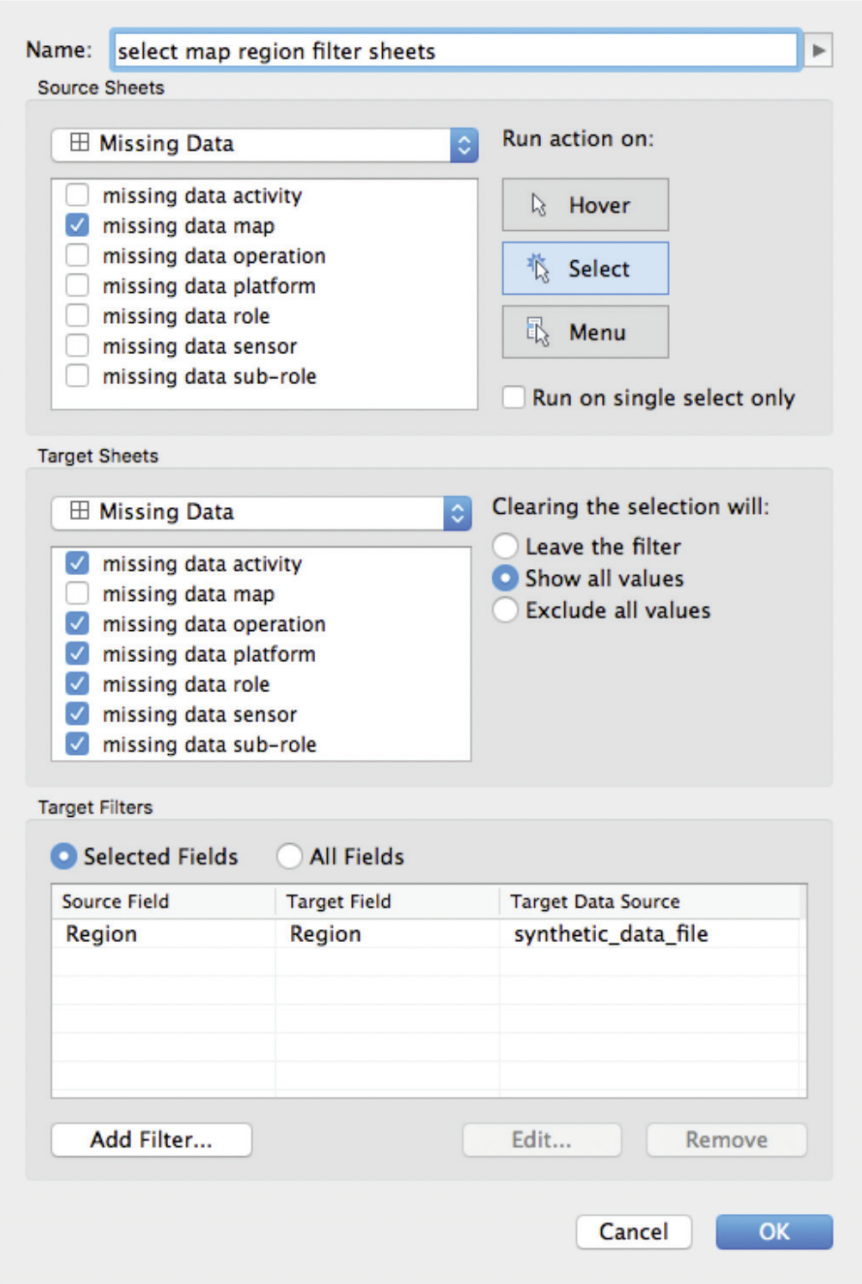
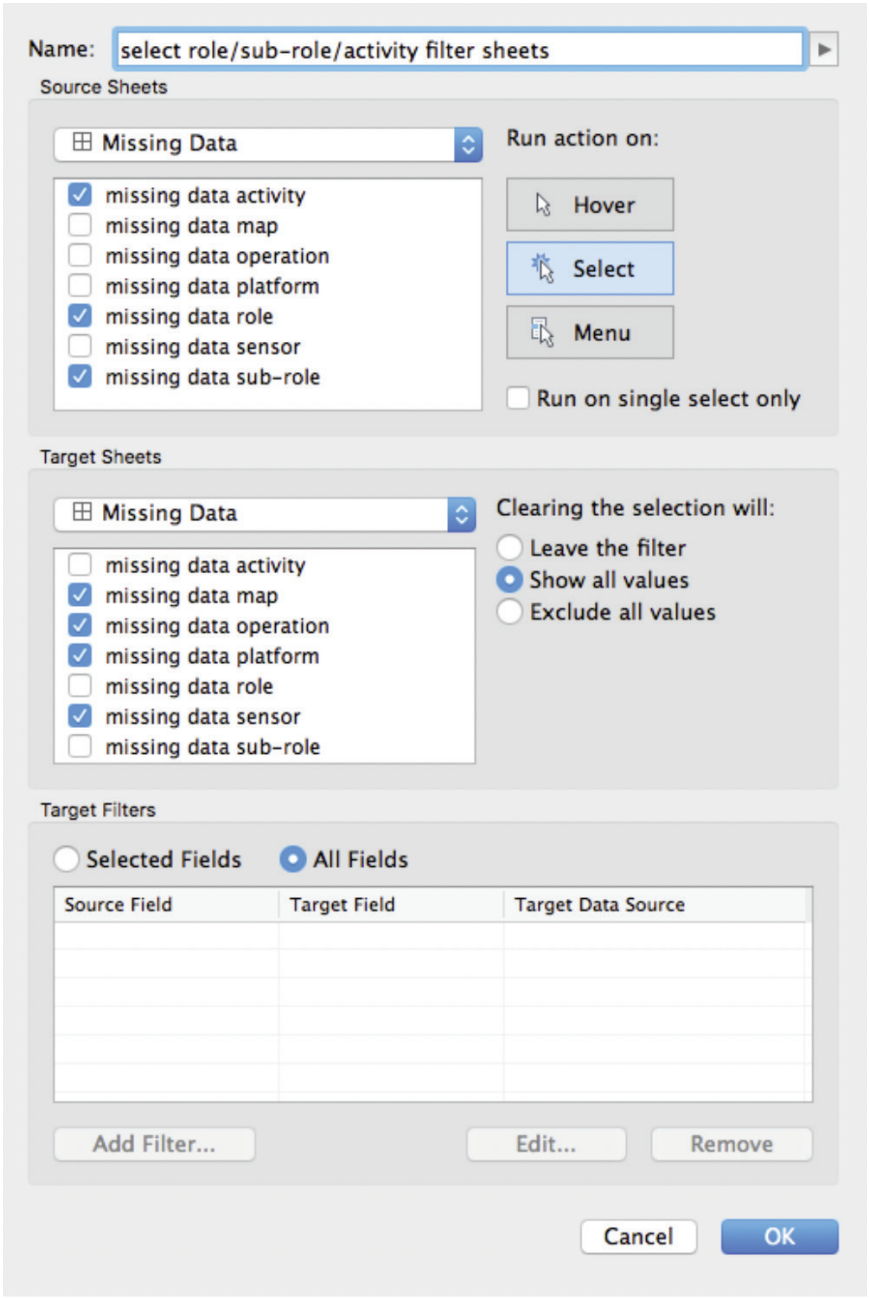


Figure 3.25
Missing Data Dashboard Filter Action



APPENDIX A

Screenshots of Dashboards

Figure A.1
Overview Dashboard: Introduction

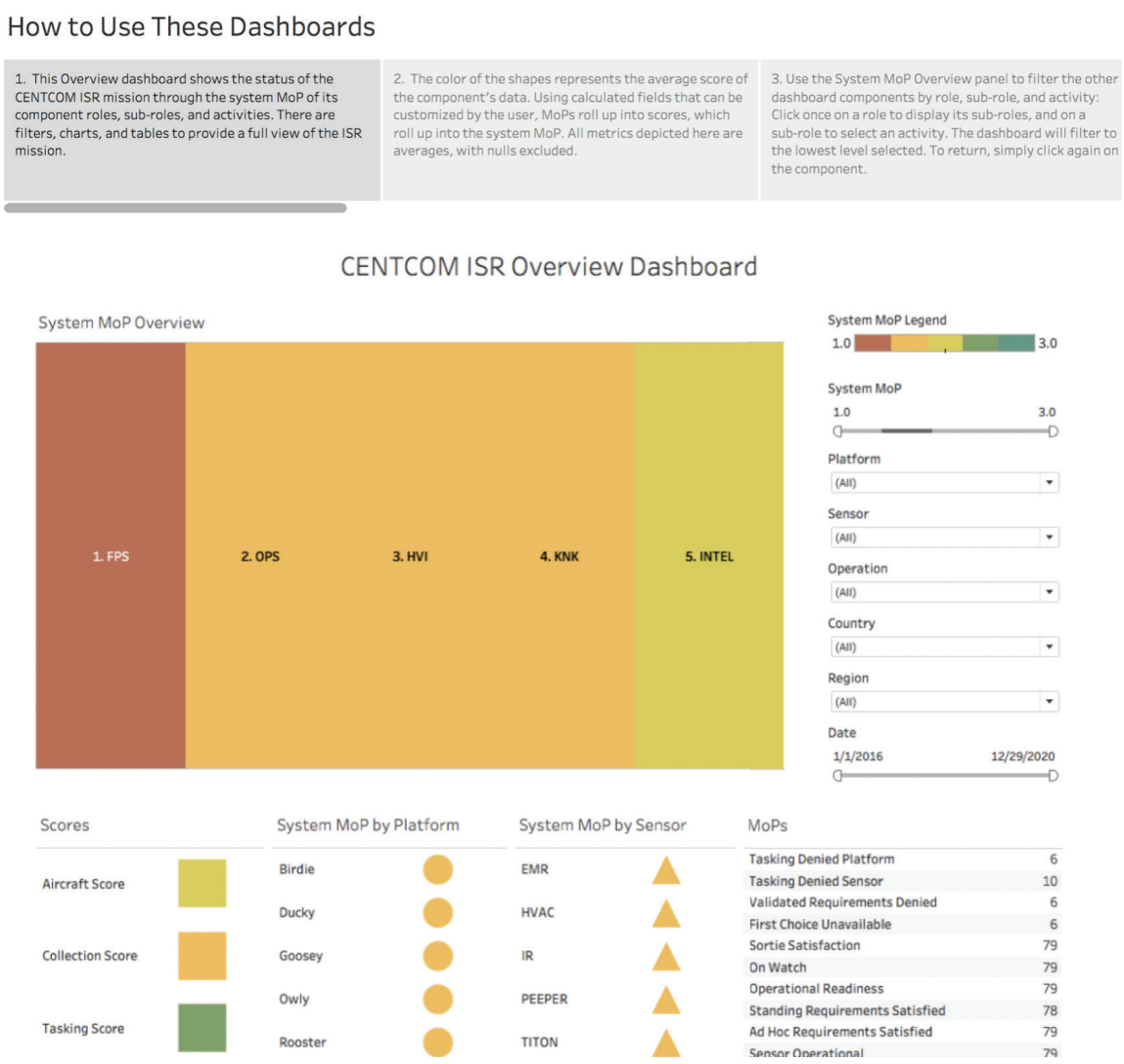


Figure A.2
Overview Dashboard: Color Legend

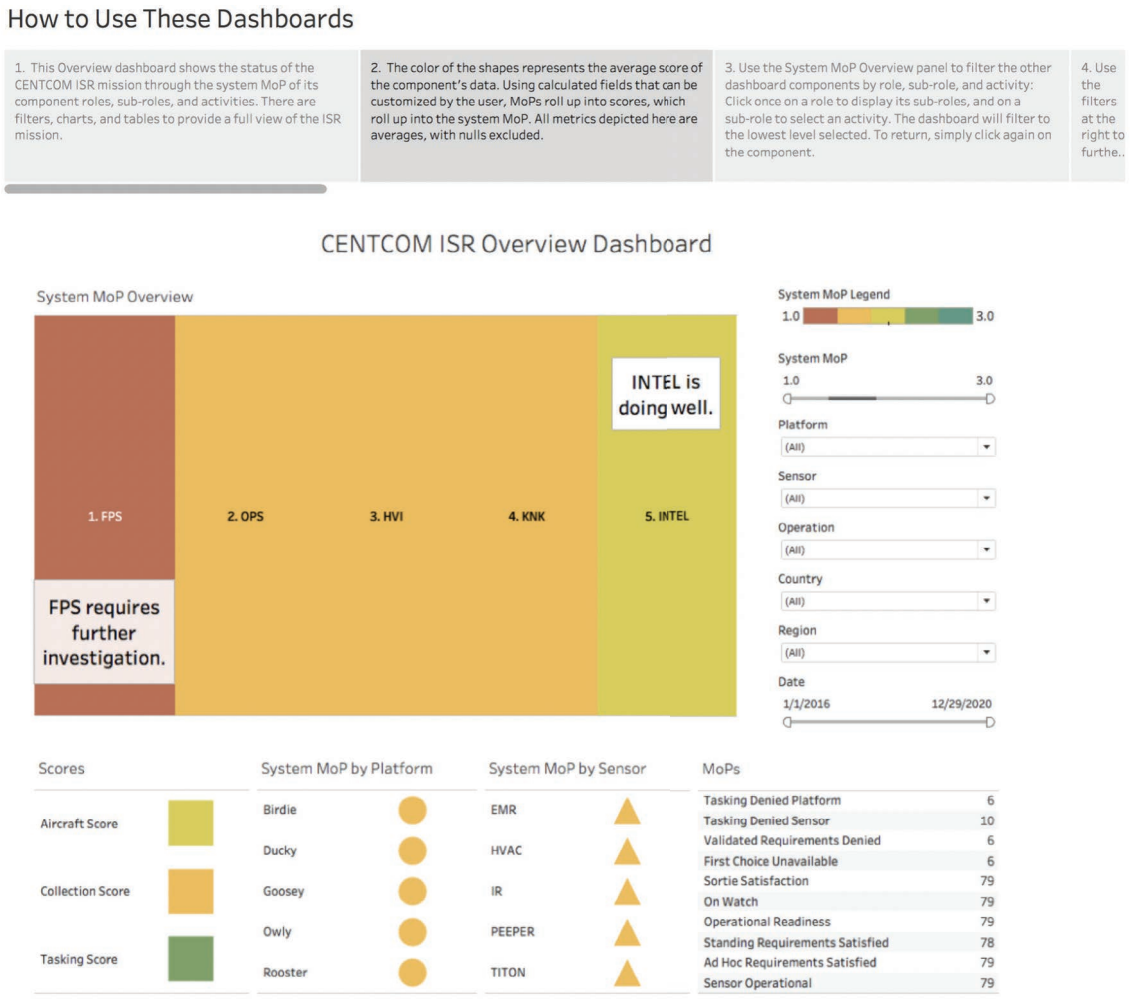


Figure A.3
Overview Dashboard: Interactivity

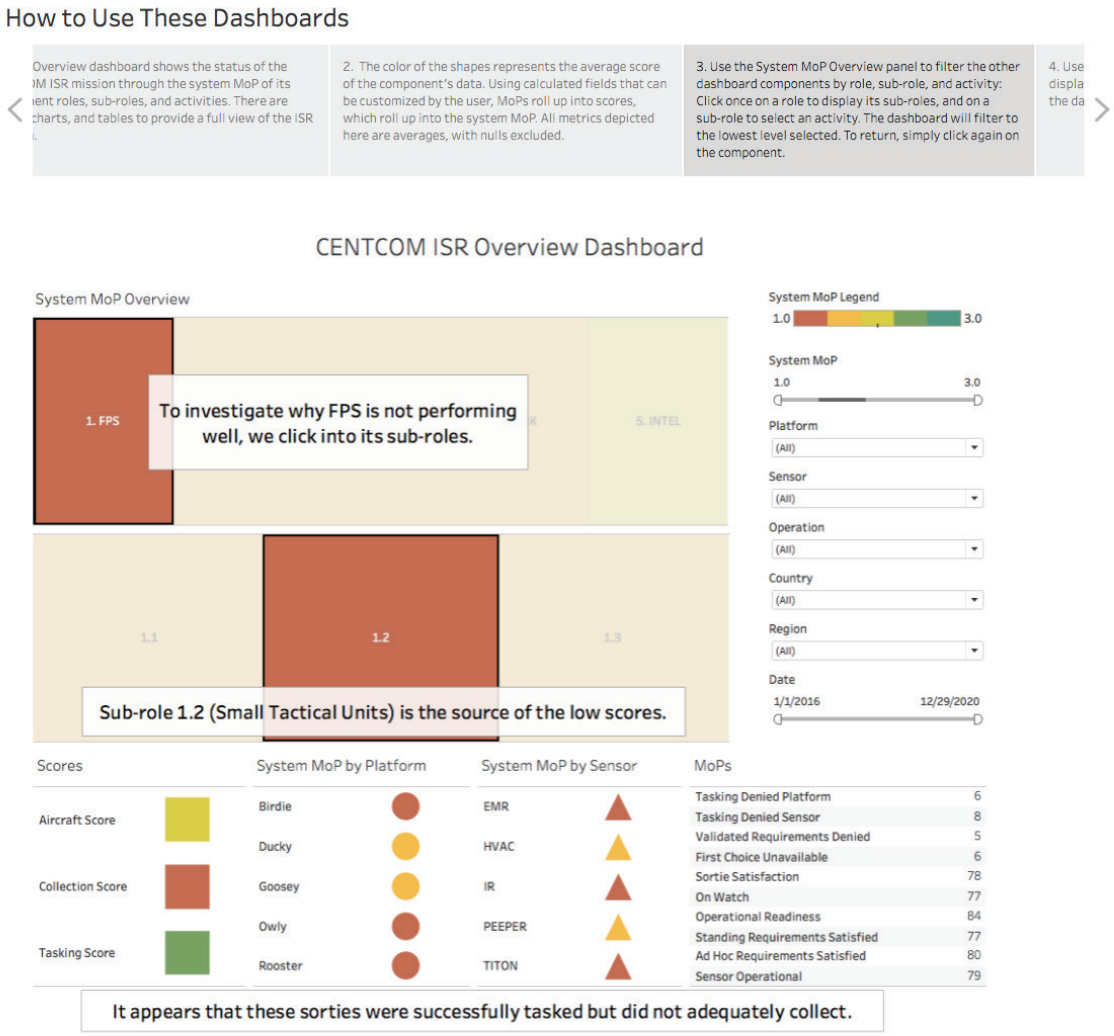


Figure A.4
Overview Dashboard: Filters

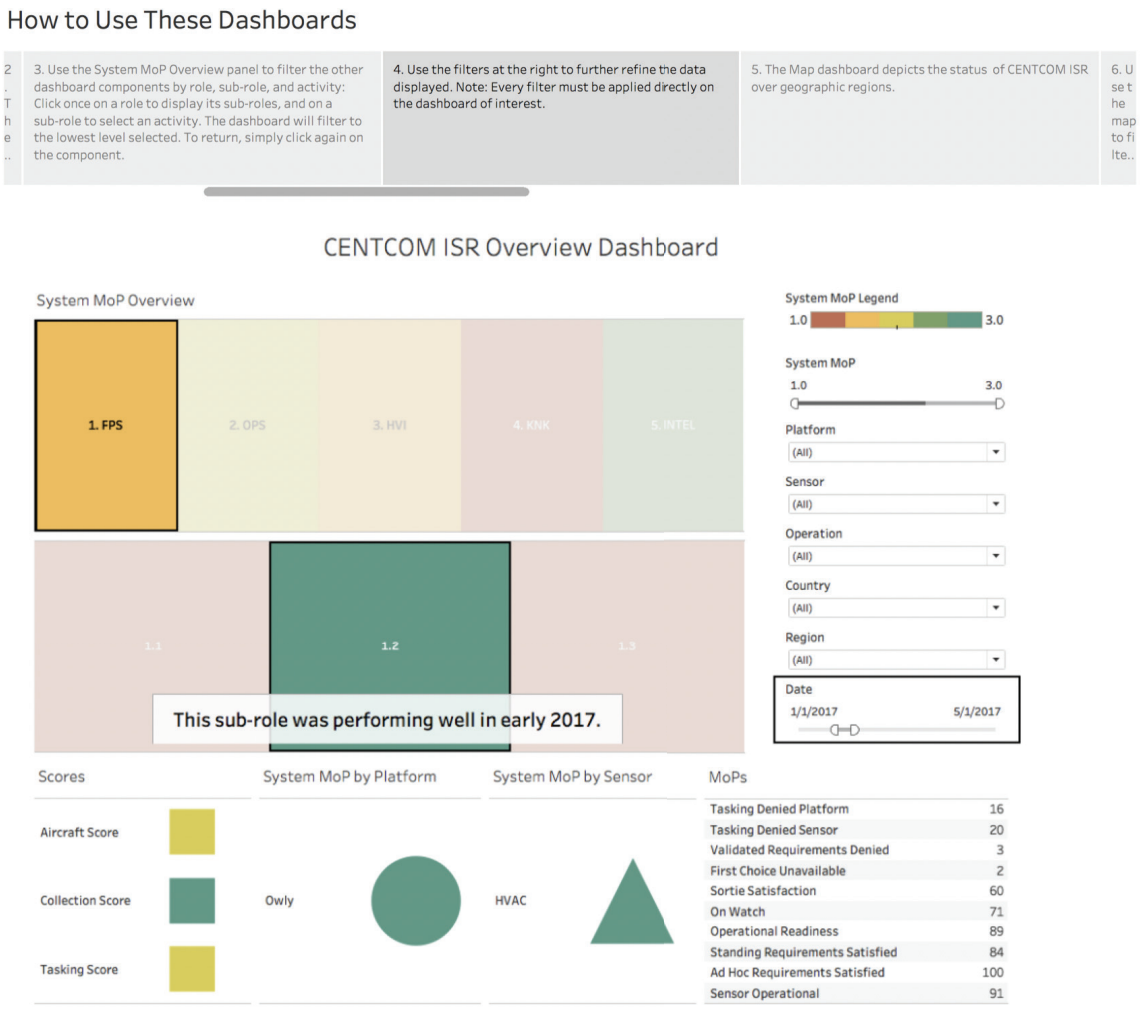


Figure A.5
Map Dashboard: Introduction

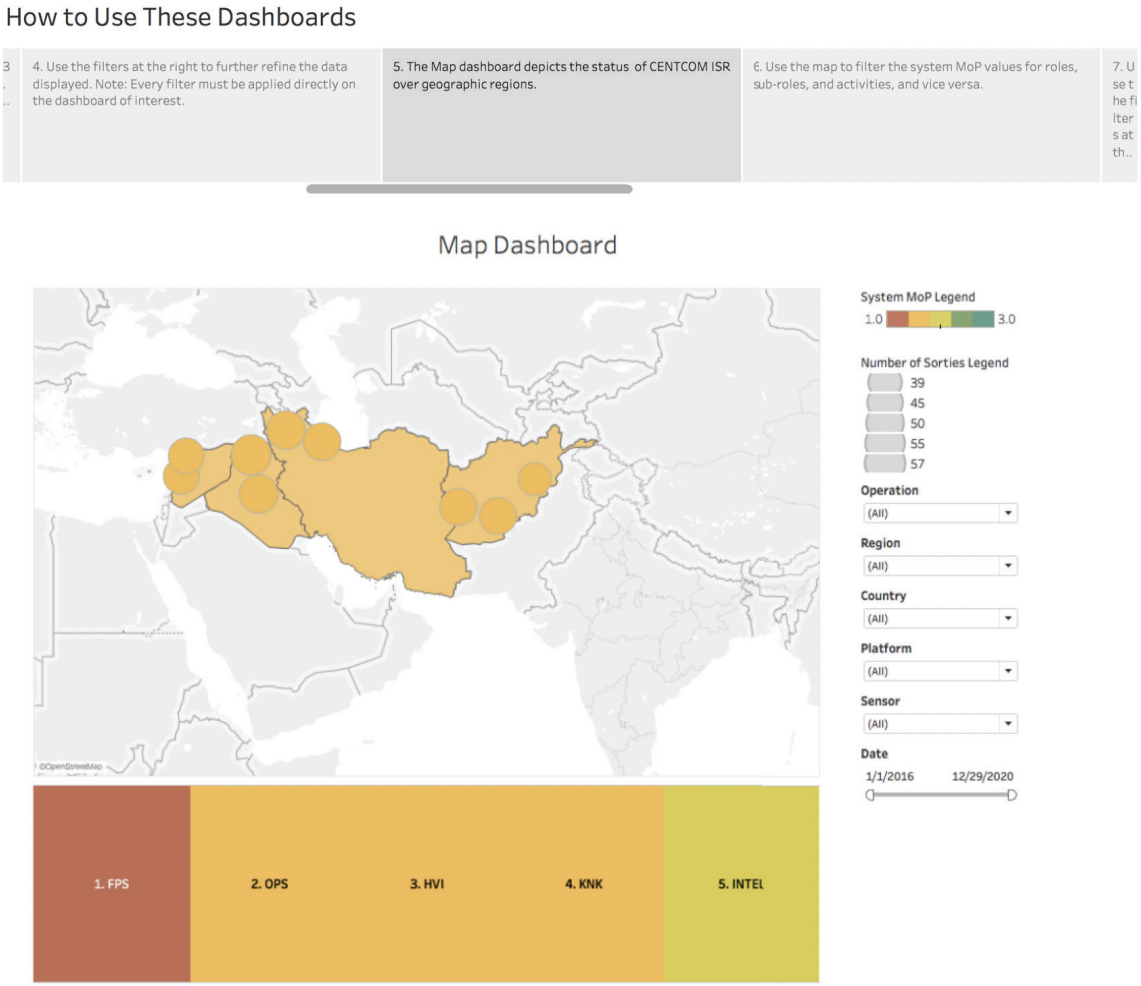


Figure A.6
Map Dashboard: Interactivity

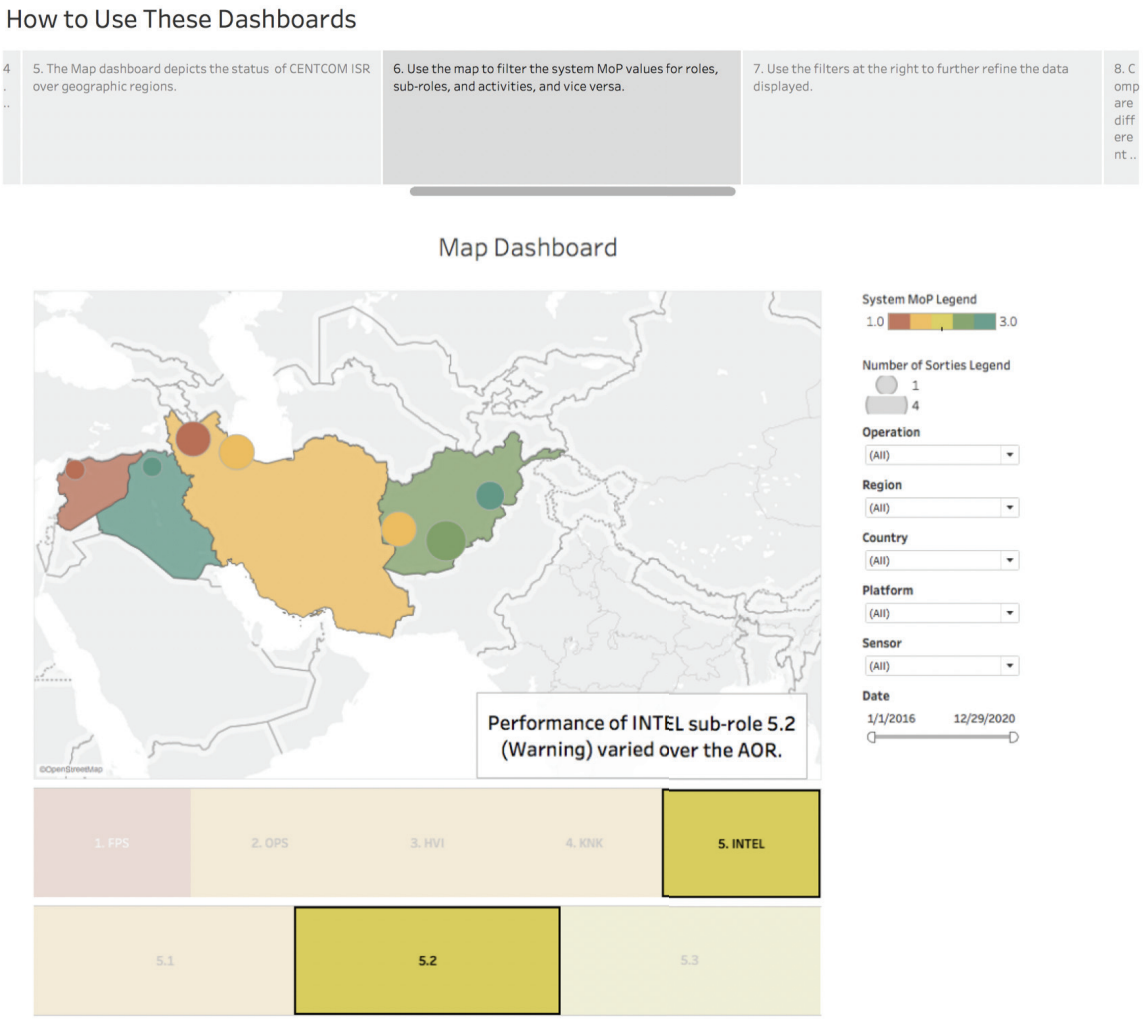


Figure A.7
Map Dashboard: Filters

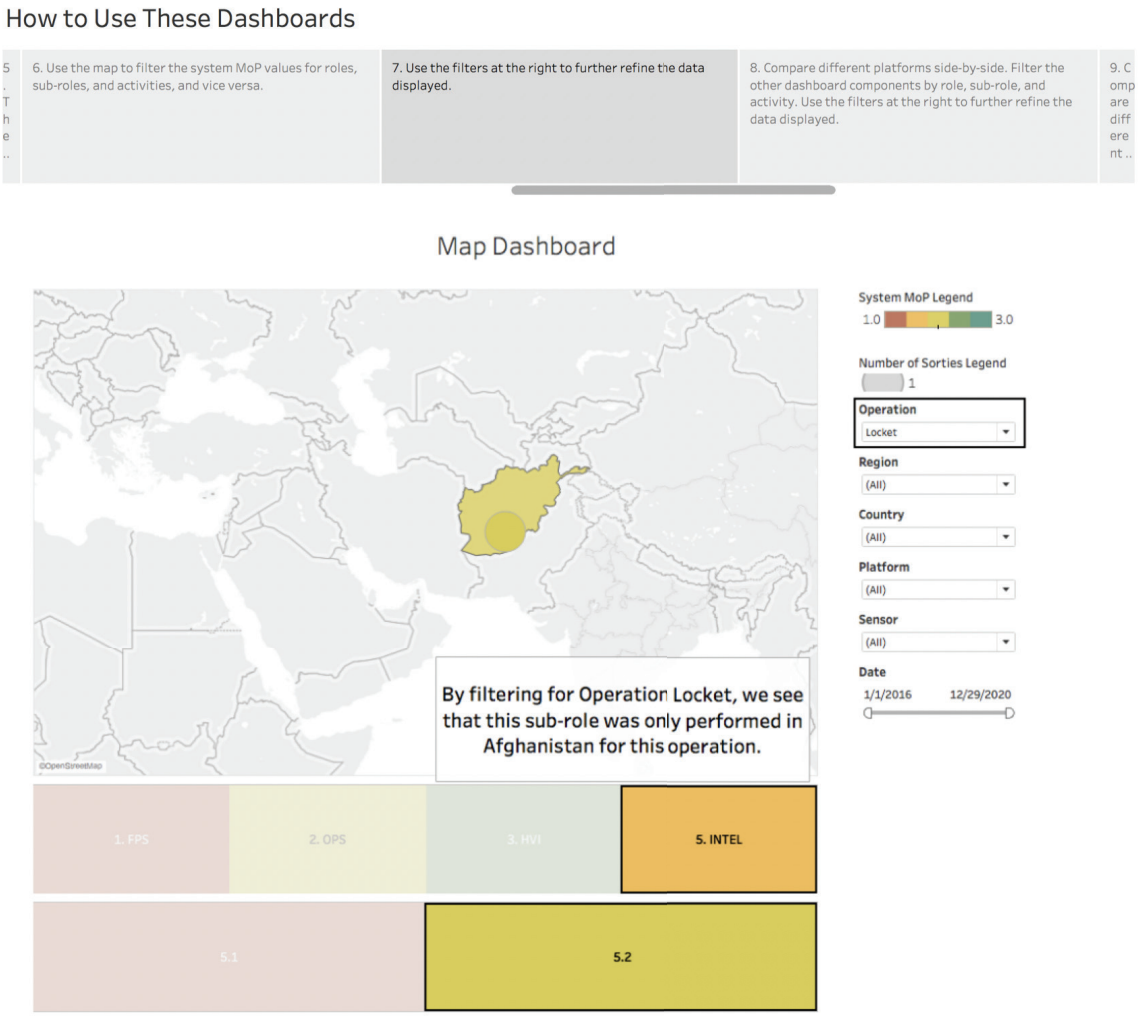


Figure A.8
Platform Comparison Dashboard

Figure A.9
Sensor Comparison Dashboard

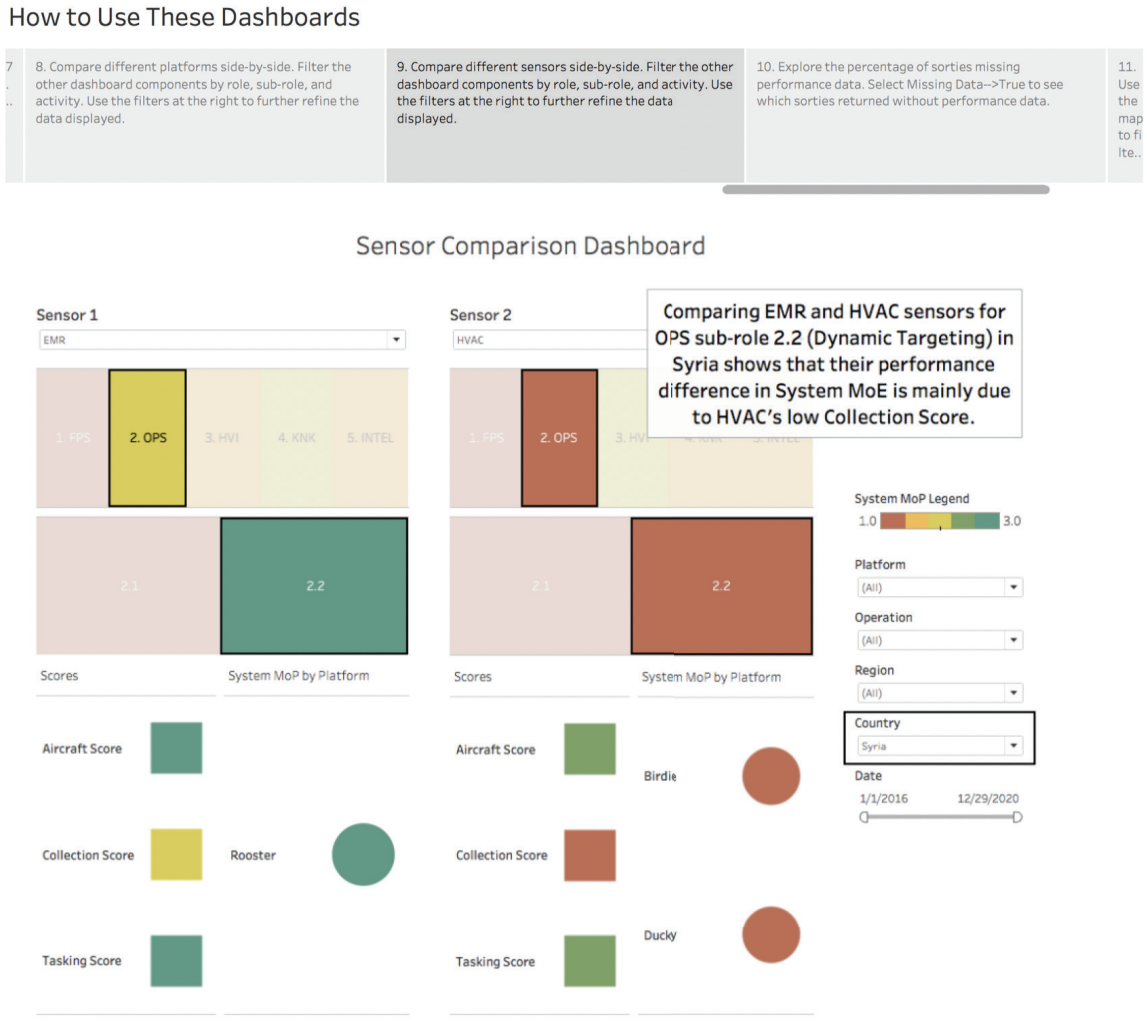


Figure A.10
Missing Data Dashboard: Interactivity

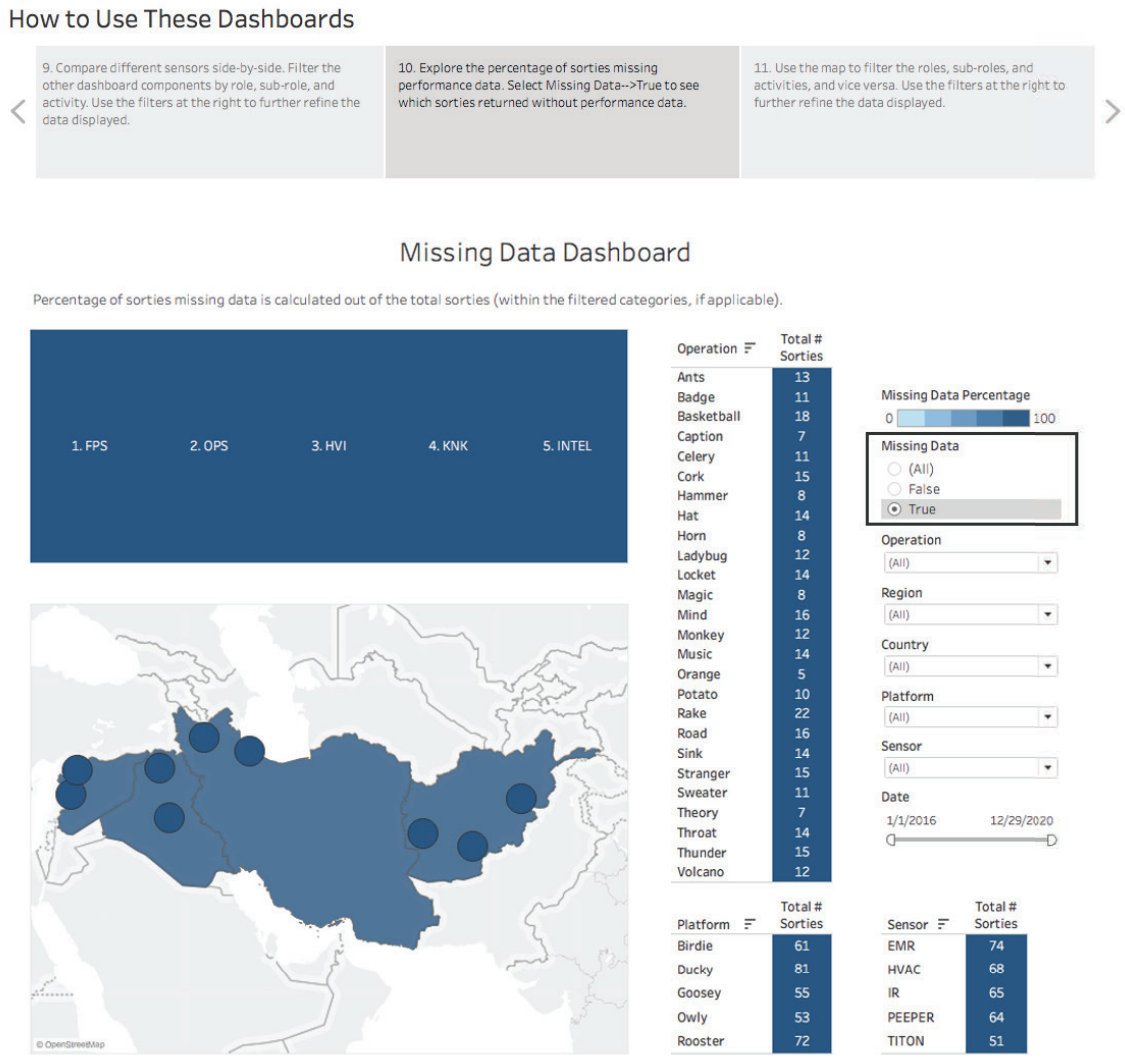
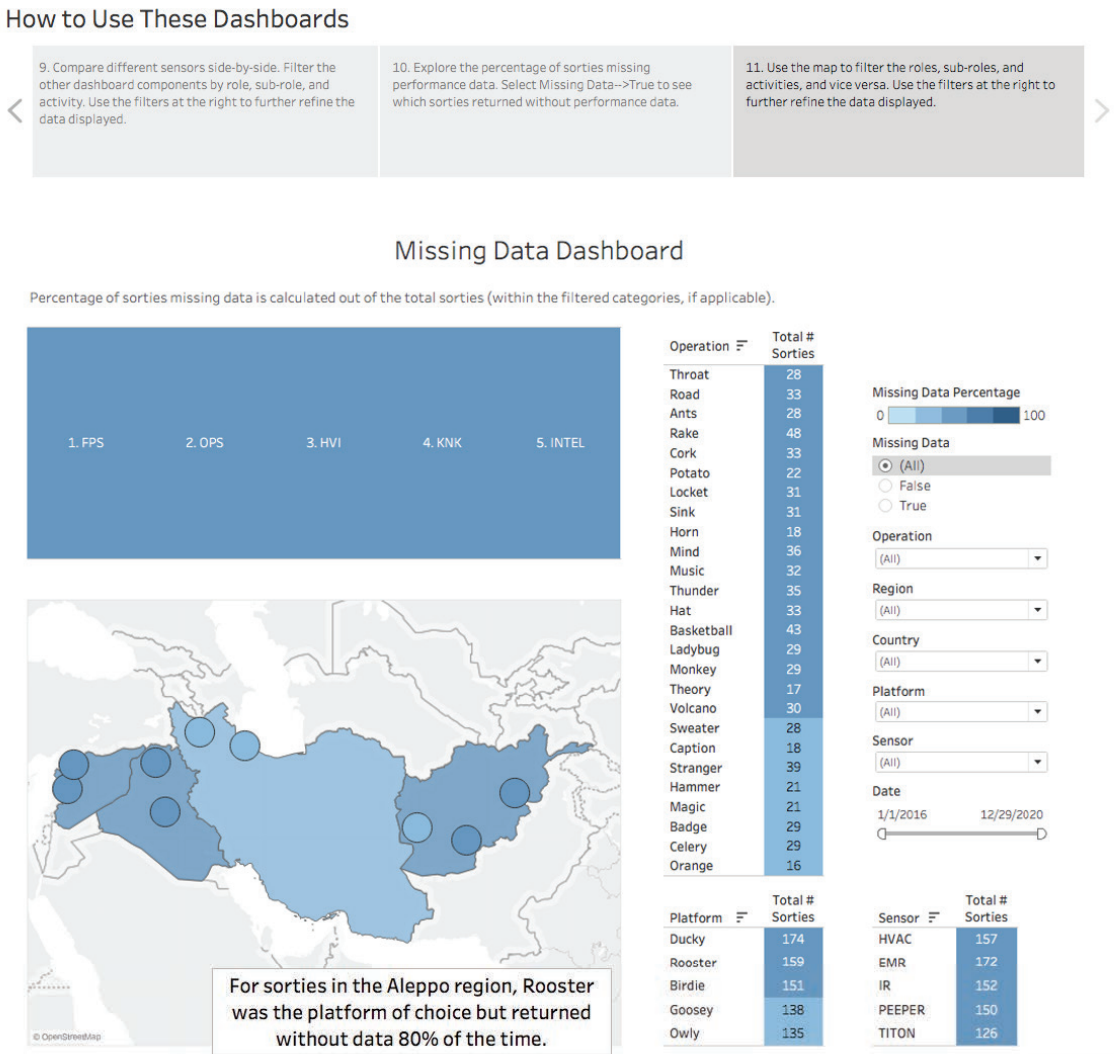


Figure A.11
Missing Data Dashboard: Filters



References

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