GPS Receivers Use-Case Information

GPS Adjacent Band Compatibility Assessment Workshop

Hadi Wassaf, *Ph.D.* **Stephen Mackey** **George Dimos**

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Topics

1. Background
2. Use Case Template
3. Description of Submitted Use-Cases from DOT Extended Pos/Nav Working Group
4. Utilization of Use-Case Information
5. Request of Information for Additional Use-Cases from GPS Receiver Manufacturers
6. Future Steps

Background

- **June 2014 :** DOT Extended Pos/Nav WG meeting in Washington DC to discuss the technical approach of the OST-R portion of the GPS Adjacent Band Compatibility Program including the need for use case information.
- **July 2014 :** GPS use-case template sent out to DOT Extended Pos/Nav WG participating civil departments and agencies
- **August 15, 2014 :** Extended Pos/Nav WG responses were due
- **September 04, 2014:** Presented initial data gathering results to the WG for data received up till August 15th
- **Today**: Updated results to reflect data received up through September 5, 2014

Use Case Template

Extended Pos/Nav WG Submitted Use Cases

Agencies That Provided Use Case Responses

- DHS(CBP, ICE, TSA, USSS)
- DOC(NIST, NOAA)
- DOI(BLM, FWS)
- DOT(FAA, FRA, MARAD)
- NASA
- DOT-CA
- USDA

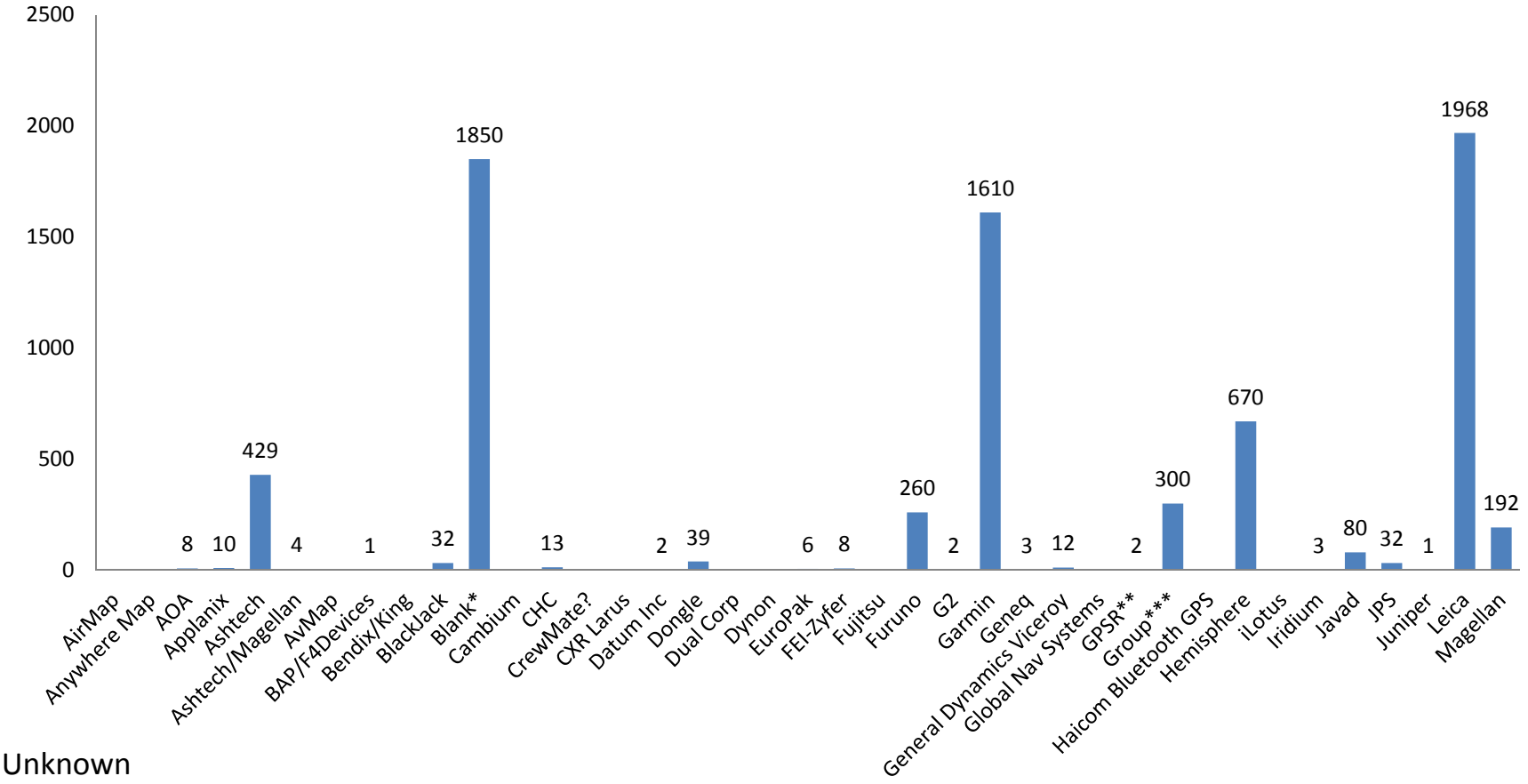
Description of Submitted Use-Cases (Up Till 08\15\2014)

Summary of Use-Case Information from Pos/Nav responses

- RECEIVER CATEGORIES, RESPONSES, Number of Units

Receiver Category	Responses	Total Known Number of Units/Future
Cellular (CEL)	1	375
General Aviation (GAV)	23	UNK
General Location/Navigation (GLN)	42	45,279/22,000
High Precision (HPR)	32	4,293/300
Timing (TIM)	28	133/45,100
Networks (NET)	3	38
Space Based (SPB)	1	16/7

Summary of Received Use-Case Information Sorted by Manufacturer (1/2)

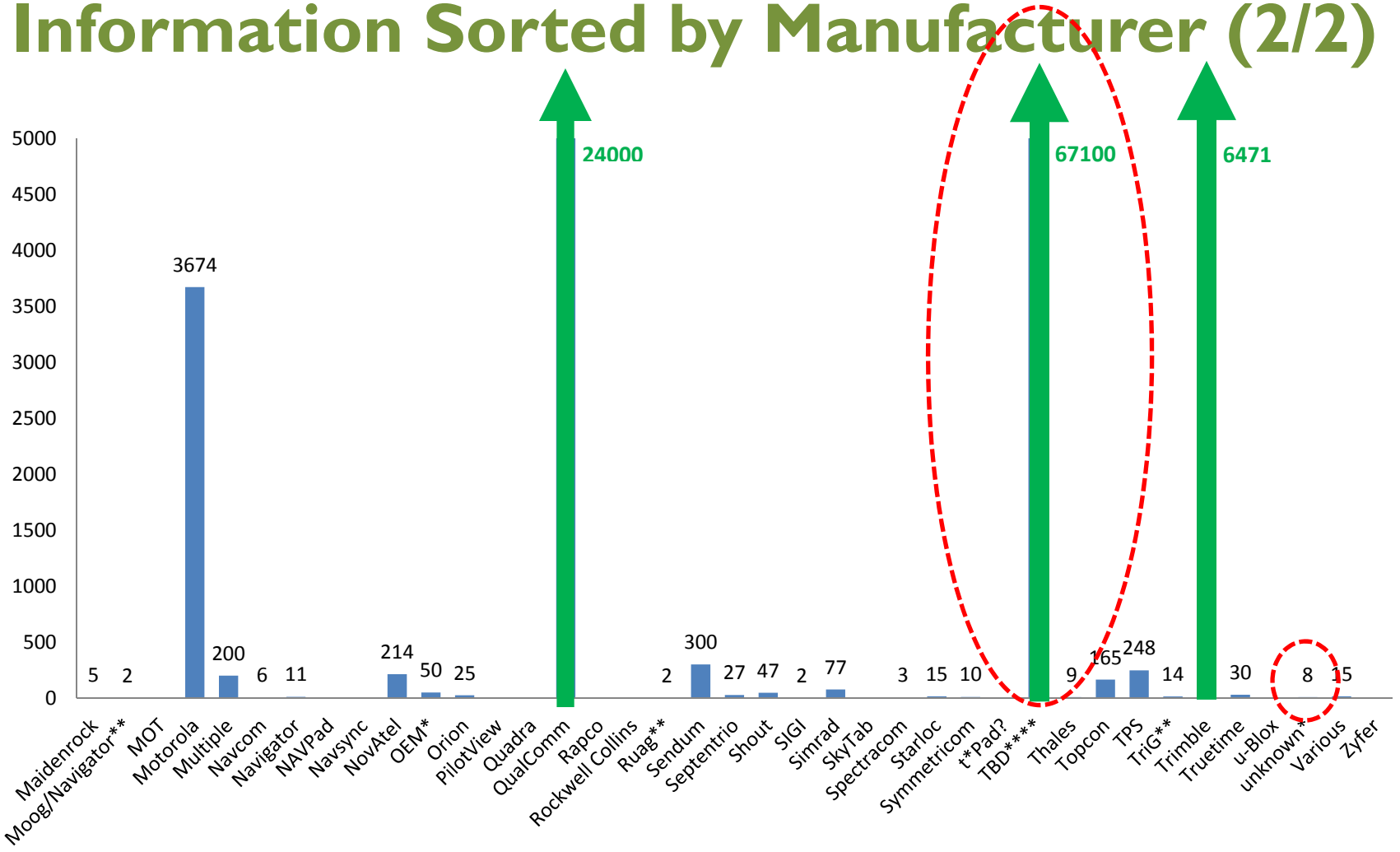


*Unknown

**To be deployed in the future

***Trimble, Ashtech, Novatel, Javad Septentrio, etc

Summary of Received Use-Case Information Sorted by Manufacturer (2/2)



*Unknown

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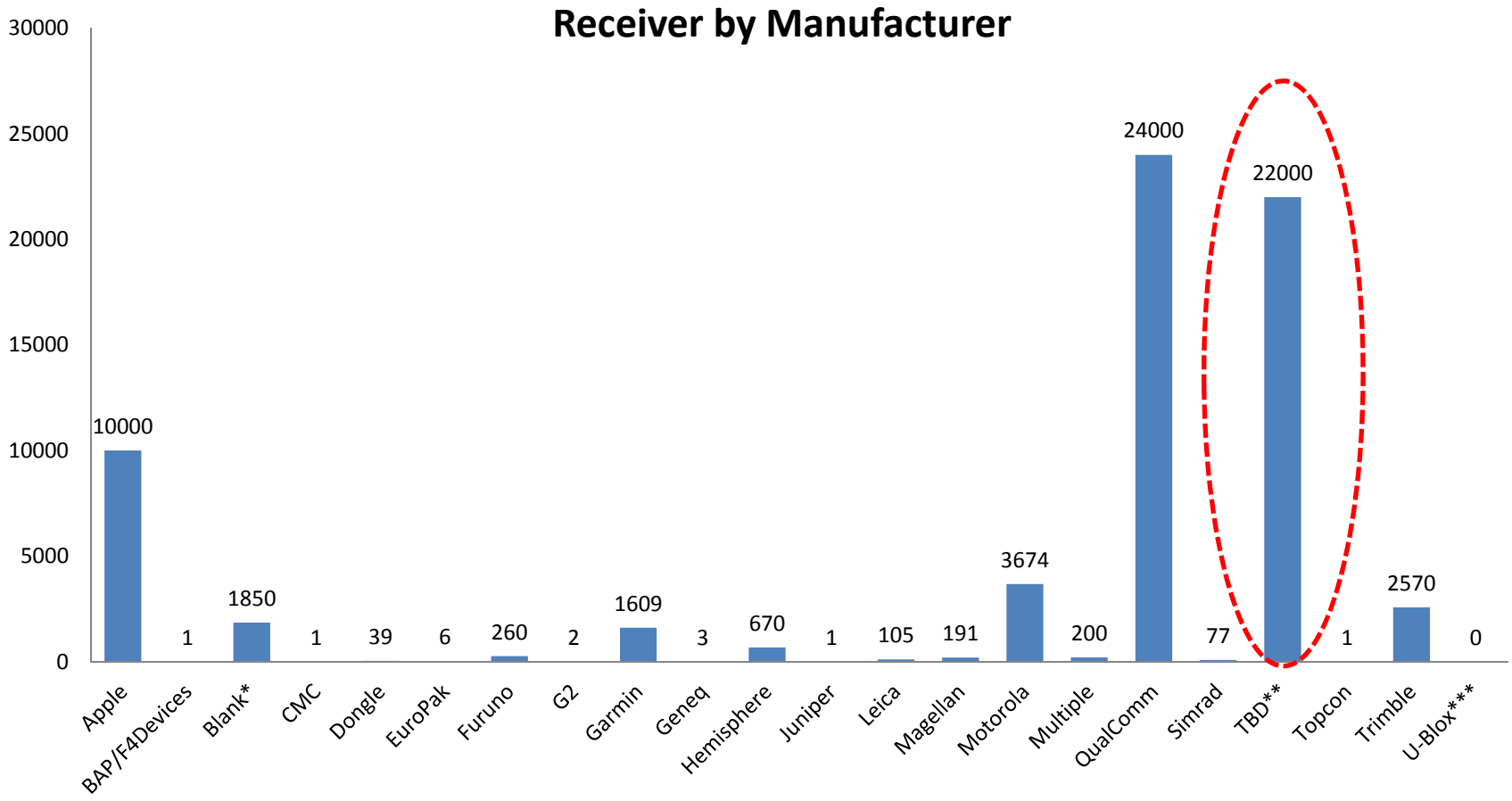
****TBD

Some Caveats

- There are a number of ambiguities on the classifications of receivers that need to be resolved:
  - For example: 22,000 receivers classified as GLN and Timing. We need to go back and get clarification
- The make/models are shown mostly as reported. We will need to validate each of the make and model and probably verify them with the reporting agencies to minimize assumptions on our side.
- We have reclassified some of the responses:
  - One response was reclassified from GLN to GAV
  - One response was reclassified from HPR to GAV
  - One response was reclassified from HPR to SPB
- A lot of TBD and Unknown receivers: Unless we get clarifications, they will clearly not be part of the pool of receivers to consider for testing although any other relevant use-case information will be considered

General Location/Navigation (GLN)

General Location/Navigation (GLN) by Manufacturer



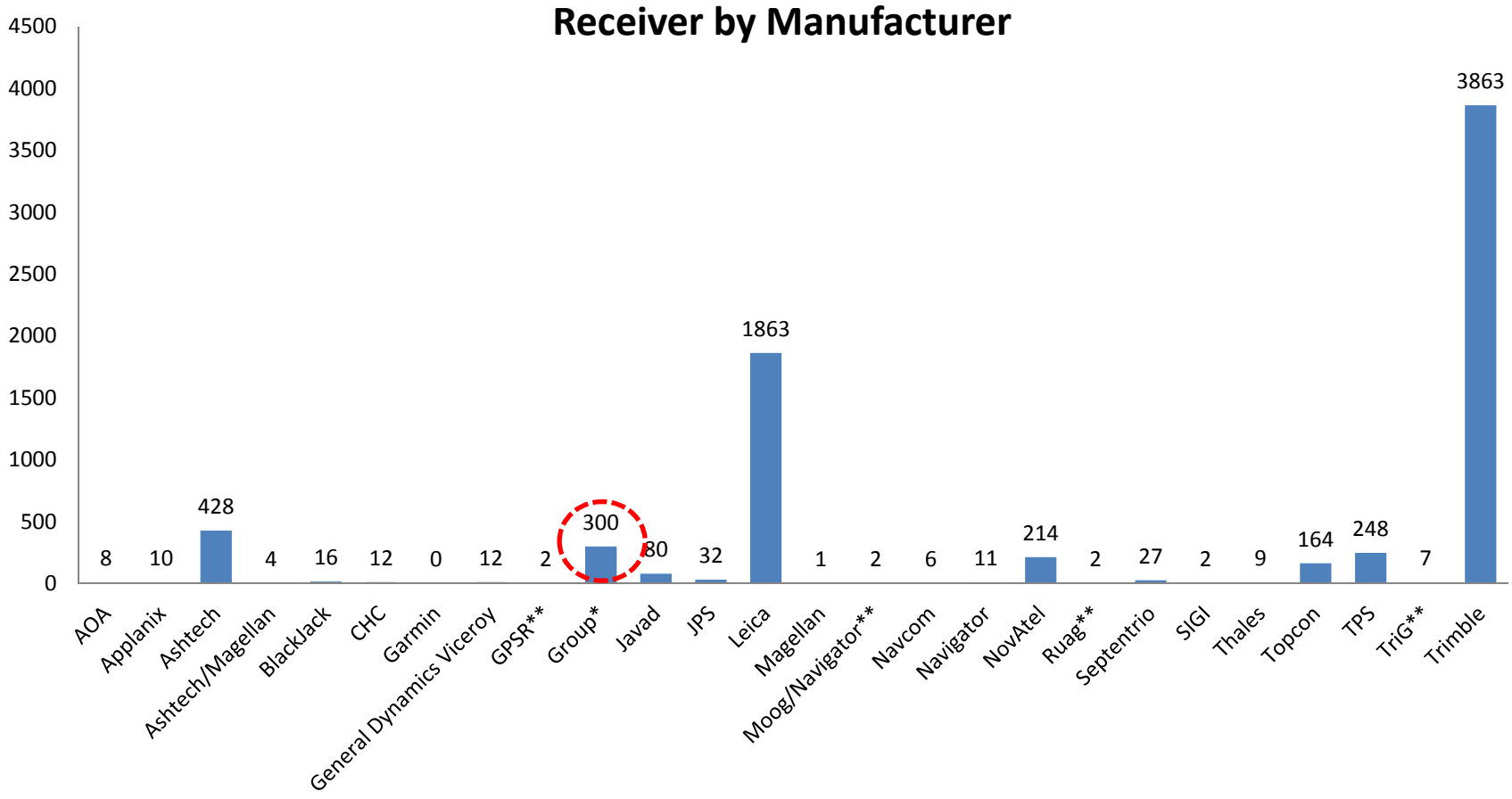
*No Manufacturer available

**22,000 GPS receivers to be deployed in the Future/Note that those are double counted under Timing

***In release process

High Precision (HPR)

High Precision (HPR) by Manufacturer



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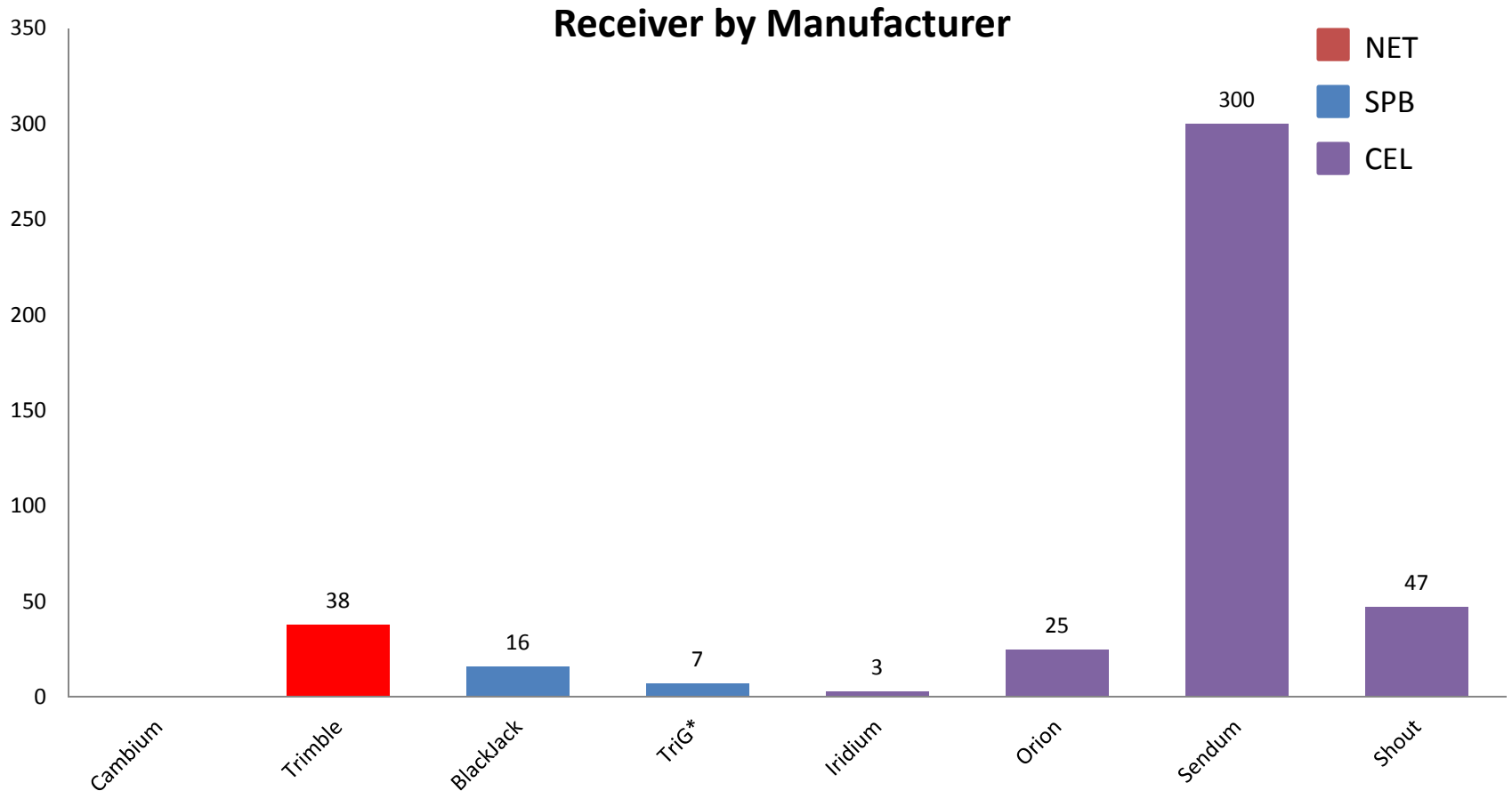
Networks (NET), Space Based (SPB), Cellular (CEL)

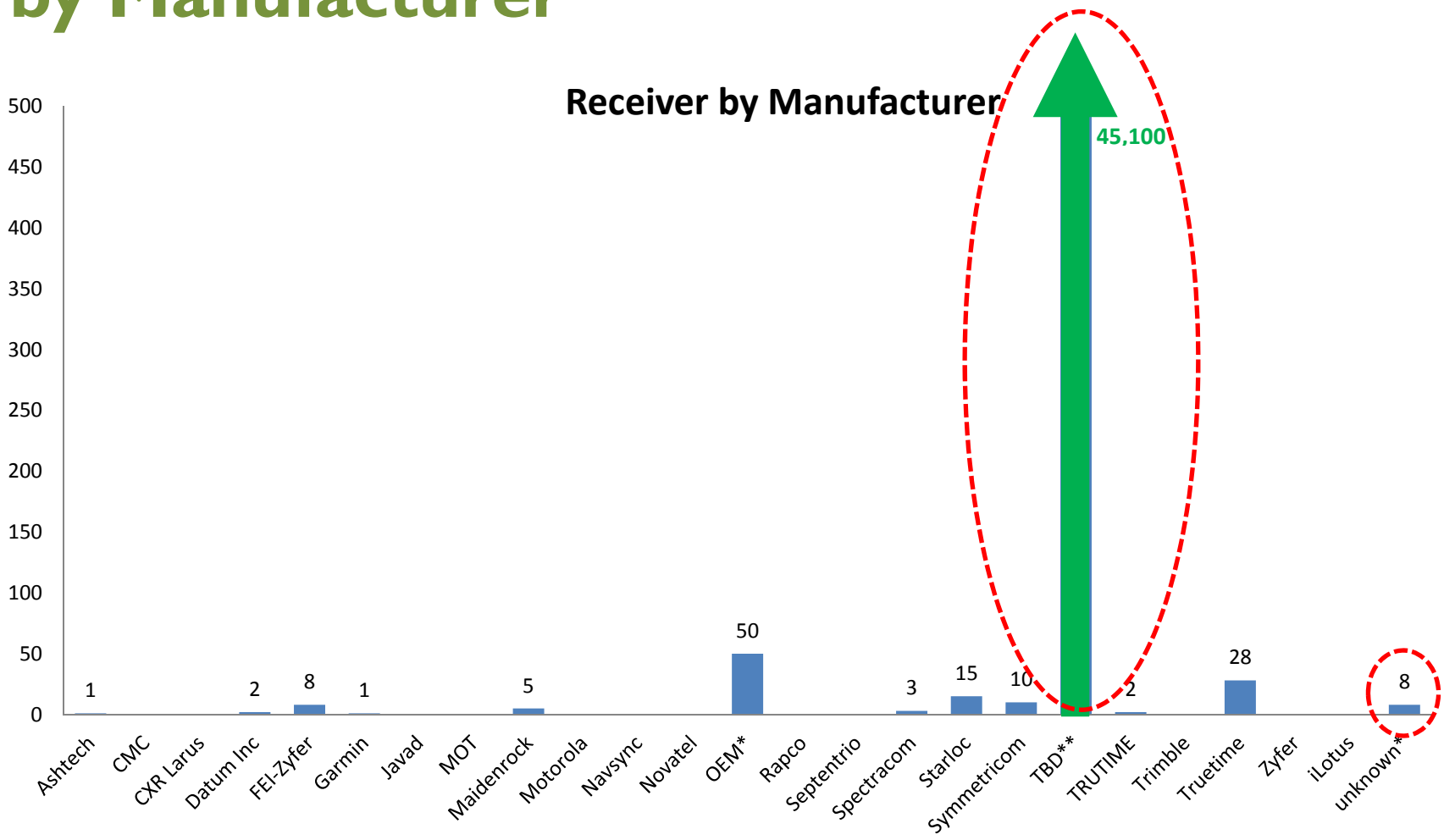
Networks (NET), Space Based (SPB), Cellular (CEL) by Manufacturer



*Launched in the Future

Timing (TIM)

Timing (TIM) by Manufacturer



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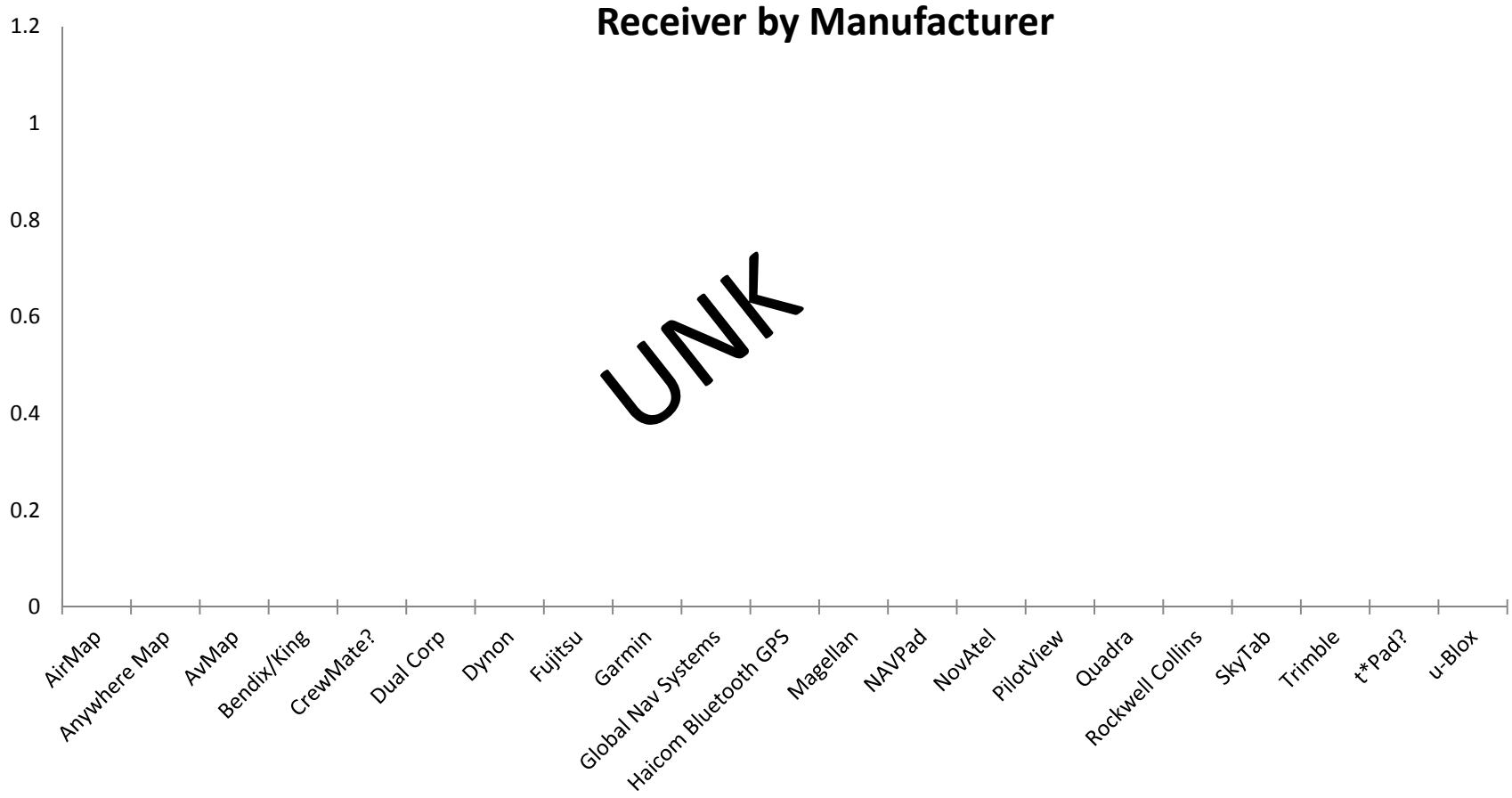
**45,100 GPS receivers to be deployed in the future will be deployed/22000 of which are double-counted under GLN

General Aviation (GAV) [Non-Precision]

General Aviation (GAV) [Non-Precision] by Manufacturer



Description of Submitted Use-Cases

- ANTENNA TYPES

Category	Make	Model	Integration	Orientation
CEL	No Response	No Response	Integrated	Fixed
GLN	>20	>20	Integrated / Separate	Fixed / Variable
HPR	>20	>20	Integrated / Separate	Fixed / Variable
TIM	Novatel, Ashtech, Symmetricom, TrueTime, Trimble	701/702/703 ASH701945G_M 58532A	Separate	Fixed (Variable in future, application to support radio networks)
NET	Trimble, Cambium	Zephyr, PTP45600	Separate	Fixed
SPB	JPL, Haig-Farr		Separate	Fixed

Description of Submitted Use-Cases

- RECEIVER ANTENNA HEIGHT AND SPEED

Category	MIN Height (ft. AGL)	MAX Height (ft. AGL)	Speed (mph)	Comments
CEL	No Response	No Response	No Response	
GAV	No Response	1,000 33,000	100 300	Aerial surveys Airborne science
GLN	0 – 5 50	2 – 15 100	0 - 10 40 - 70 150 35	 Mississippi river, soloforest Data collection Provide constant lat/lon pos.
HPR	0 - 5	2 – 33 0 - 100	0 - 10 0 - 45 15 – 60	 Cadastral boundary surveys Mobile terr. Laser scanning Ground networks
TIM	0 - 8	15 - 100 150	0 100	 Future radio support
NET	0 - 7	7 - 130	0	
SPB	1,700,000	4,300,000	16,000	

Description of Submitted Use-Cases

- URBANIZATION AND TERRAIN

Category	Urbanization (mostly)	Terrain (mostly)
	URBAN / SUBURBAN / RURAL	FLAT/SLOPED/CANYON – OPEN/IMPEDED – DRY/WET
CEL	Urban/Suburban/Rural	Flat/Sloped/Canyon – Open/Impeded - Dry
GAV	Rural	Flat - Open - Dry
GLN	Urban/Rural/Suburban	Flat/Sloped/Canyon - Open/Impeded - Dry/Wet
HPR	Urban/Rural/Suburban	Flat/Sloped/Canyon - Open/Impeded - Dry/Wet
TIM	Urban/Rural/Suburban	Flat/Sloped/Canyon - Open/Impeded - Dry
NET	Urban/Rural	Flat/Sloped - Open - Dry
SPB	N/A	N/A

Utilization of Use-Case Information

- The use-cases collected have the following 2 primary purposes:
  A. Identifying the receiver types and associated applications
  B. Collecting input to the network aggregation tool

A. Identifying Receiver Types and Associated Applications (1/2)

- An integral part of the current Adjacent Band Compatibility work is the development and implementation of a receiver test plan to assess harmful interference levels in the adjacent band.

- The receivers in the use case responses will be considered candidate receivers to be tested.

- However, a set of agreed upon criteria must be used to down-select from a set of “representative” receivers to be tested.

A. Identifying Receiver Types and Associated Applications (2/2)

- What should the down-selection process entail? Possible criteria are:
  - The number of units deployed (must be greater than some threshold)
  - Type and/or criticality of the application
  - Whether a particular receiver model is known to bound the performance of some other receiver models from the same manufacturer , (i.e. representative of other receiver for the same application).
    - This is to eliminate redundant testing
    - This requires going through receiver specifications and working with manufacturers
  - **Testing Feasibility**:
    - Whether the receiver hardware and software permit easy access to the relevant information (SNR, other spectral information, Pseudorange error, Loss of Lock and other Alarms, etc…)
    - In the case of integrated Antenna/Receiver: Accessibility to receiver input port for a wired test.

B- Collecting Input to the Network Aggregation Model (1/7)

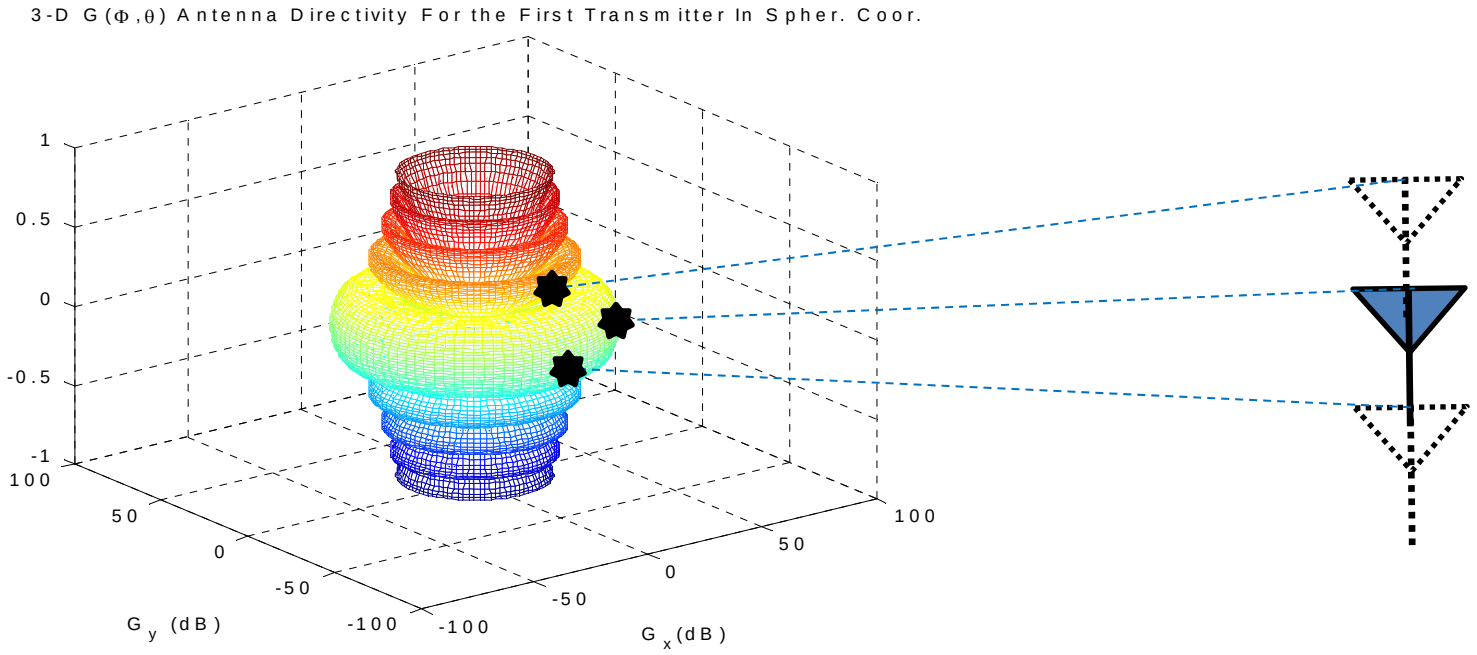
- Volpe is in the process of developing and implementing a Network power aggregation tool based on known and established propagation models.
- The purpose of this tool is to estimate the RFI power coupled into a GNSS receiver antenna based on a wireless network characteristics with flexible attributes
- The use cases determine some of the ranges of inputs to be used when looking at an interaction scenario using the aggregation tool

B- Collecting Input to the Network Aggregation Model (2/7)

- The relevant use-case information for the aggregation tool are:
  i. Range of Antenna Heights
  ii. Antenna Orientation: Fixed or Variable
  iii. Urbanization Level
  iv. Terrain Attributes
  v. Mobility/Maneuvering Speeds

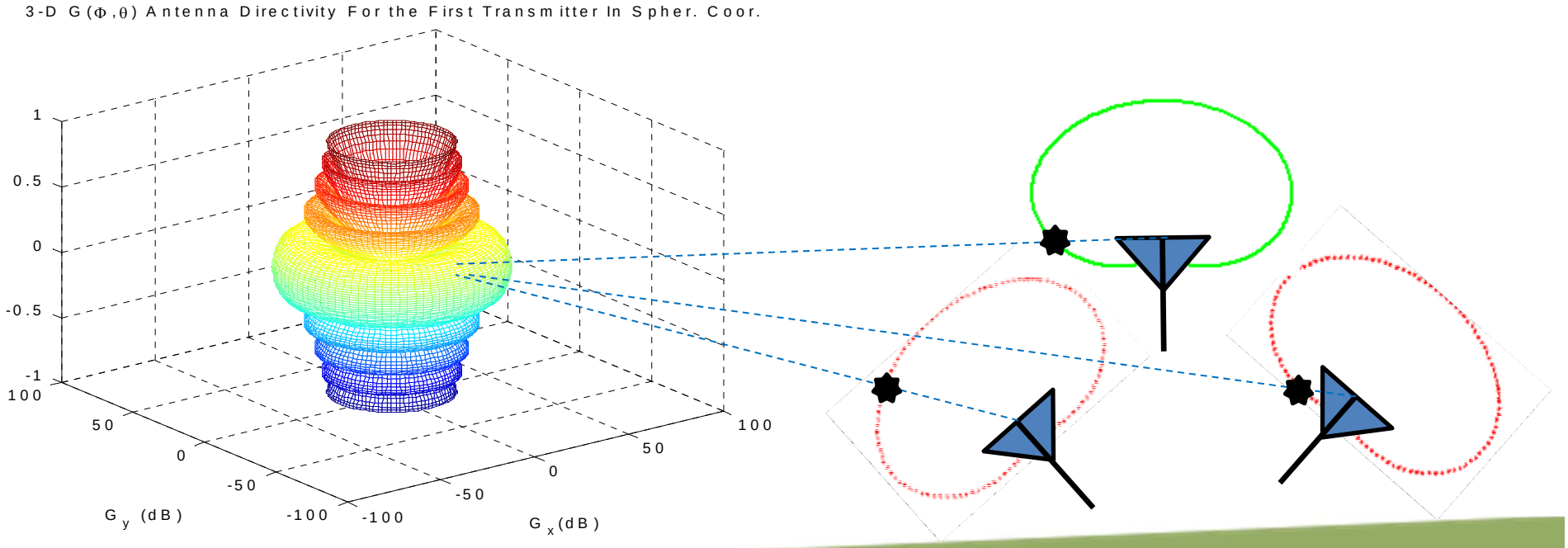
B- Collecting Input to the Network Aggregation Model (3/7)

i. The GNSS antenna height (or relative height to transmit antenna) determines the effects of each transmitter antenna pattern on the coupled RFI power level.



B- Collecting Input to the Network Aggregation Model (4/7)

ii. GNSS Receiver Orientation: determines the receiver antenna pattern effects on power coupling



B- Collecting Input to the Network Aggregation Model (5/7)

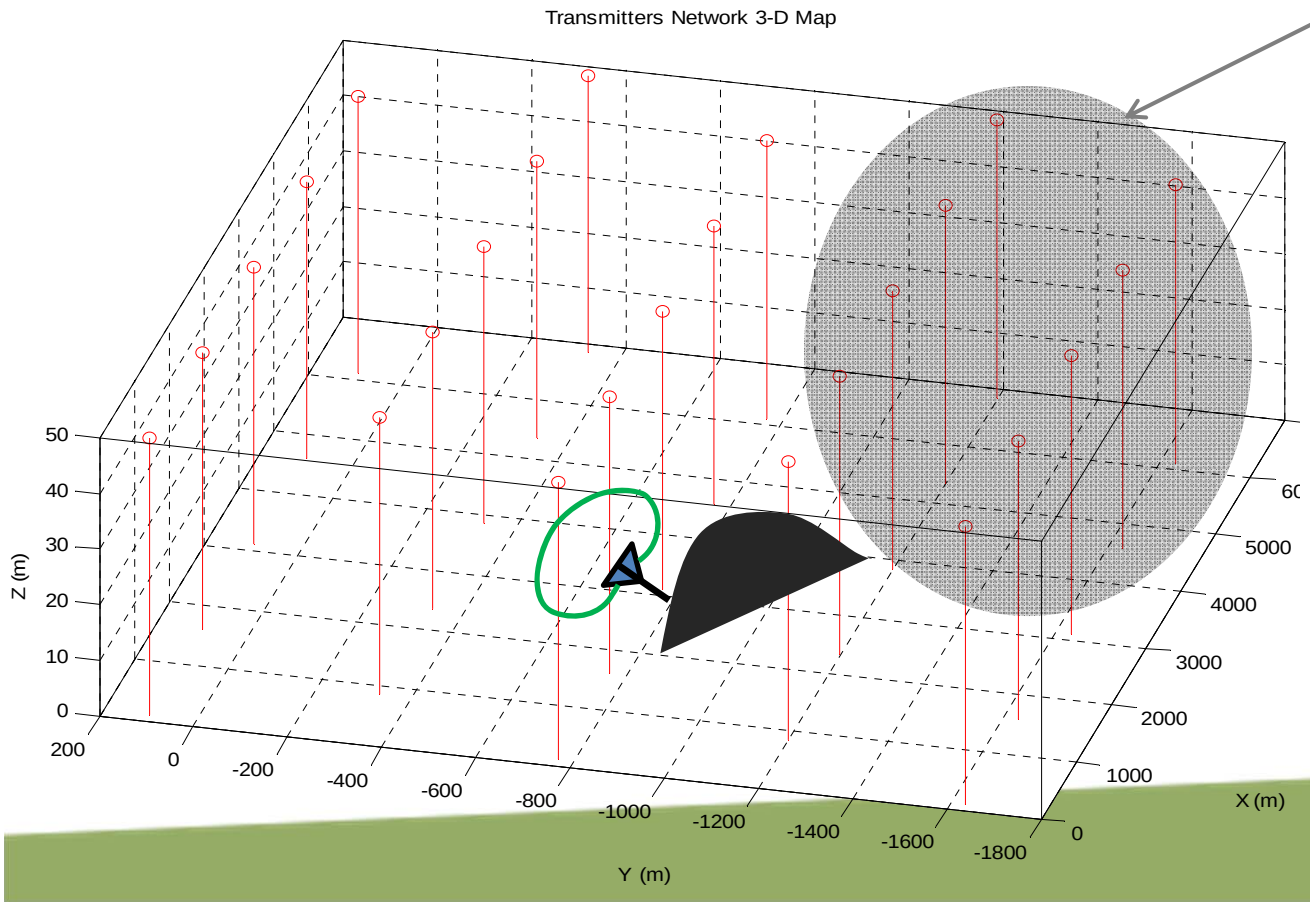
iii. Urbanization Level:

- This information is primarily relevant to the electromagnetic propagation. The choice of parameters for these propagation models are based on the urbanization levels among other contributing factors

B- Collecting Input to the Network Aggregation Model (6/7)

iv. Terrain attributes have two main effects:

- Affects Antenna orientation
- Blockage for a sector of the interfering network



B- Collecting Input to the Network Aggregation Model (7/7)

v. Mobility/Maneuvering speeds:

- This is not an explicit input to the model. The primary utilization of this parameter is to get a feel of how dynamic the scenario is.

- For example, in a complex terrain the speed can be informative on how long a scenario is expected to be static. That is, how often a scenario can change in the course of one hour (for example).

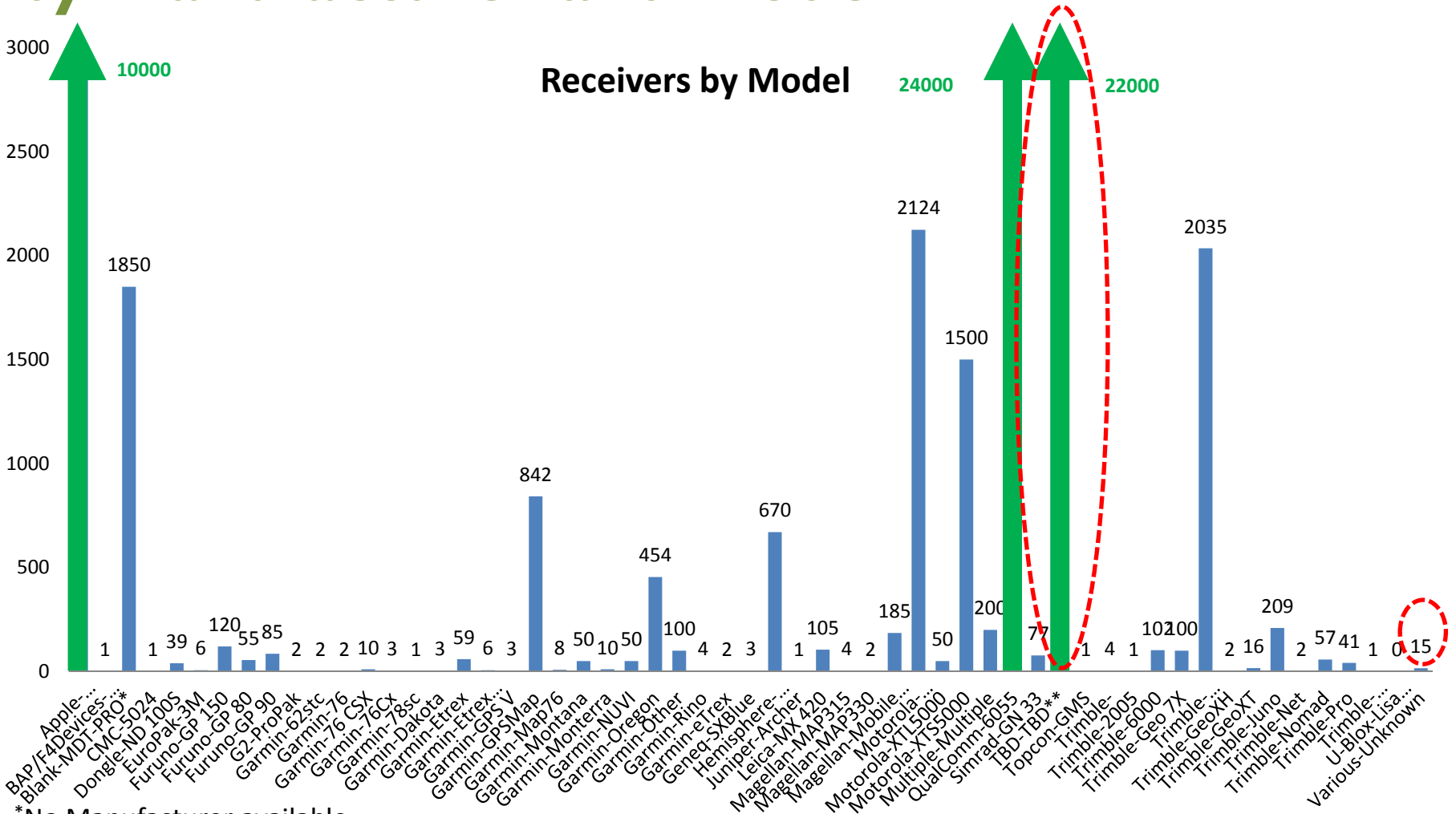
Request Use-Cases from GPS Receiver Manufacturers

- Although the collected responses from US agencies reveal a wide diversity of specialized applications, the number of receiver units involved is probably not representative of the total number of active GPS receivers in the US.

- It is desirable that the DOT Extended Pos/Nav Working Group responses be complemented with **additional information from receiver manufacturers, academic institutions, or other sources**, regarding the characteristics of prominent applications which involve the bulk of the GPS receiver units in the US.

Appendix

General Location/Navigation (GLN) by Manufacturer and Model



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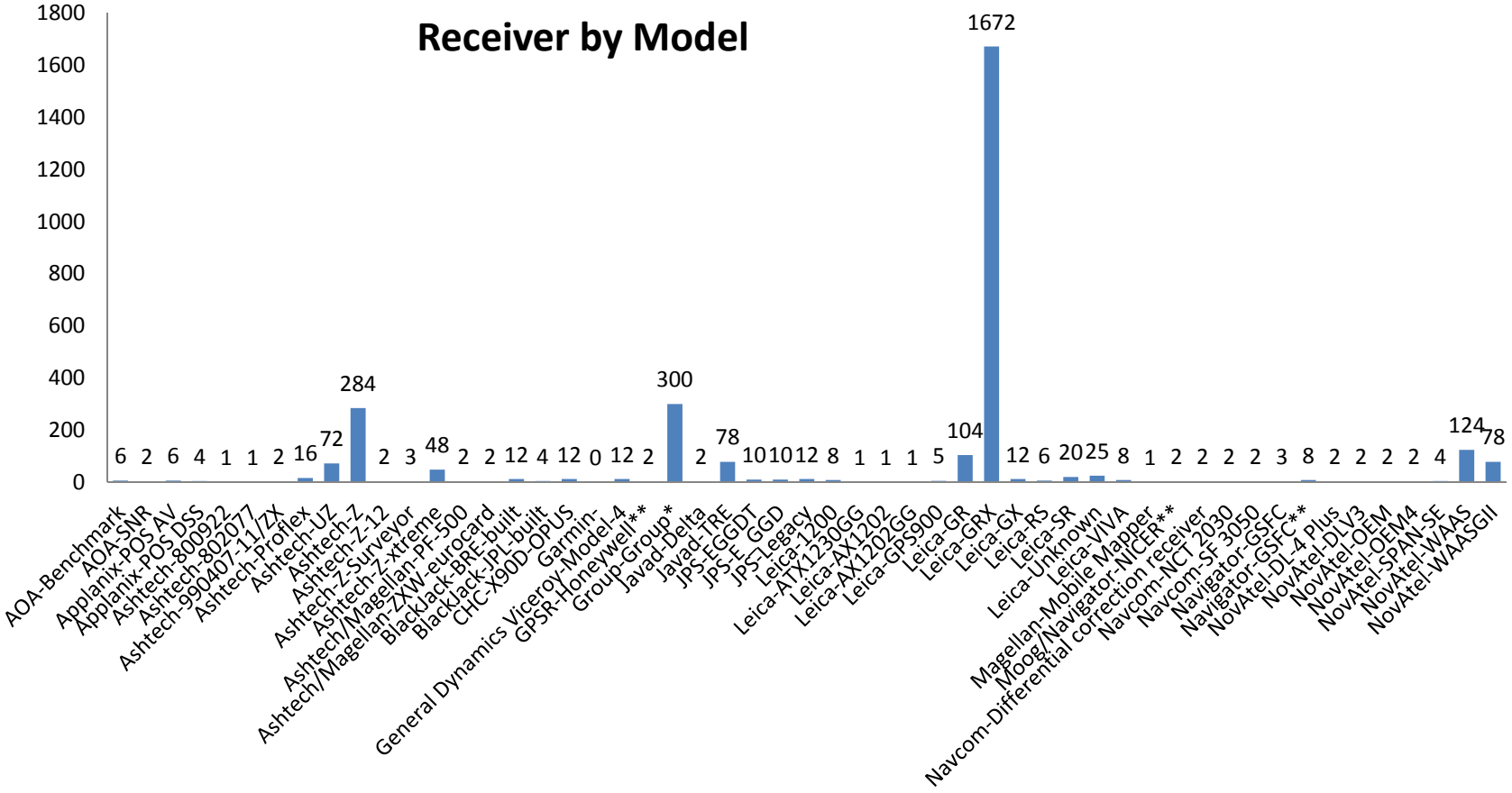

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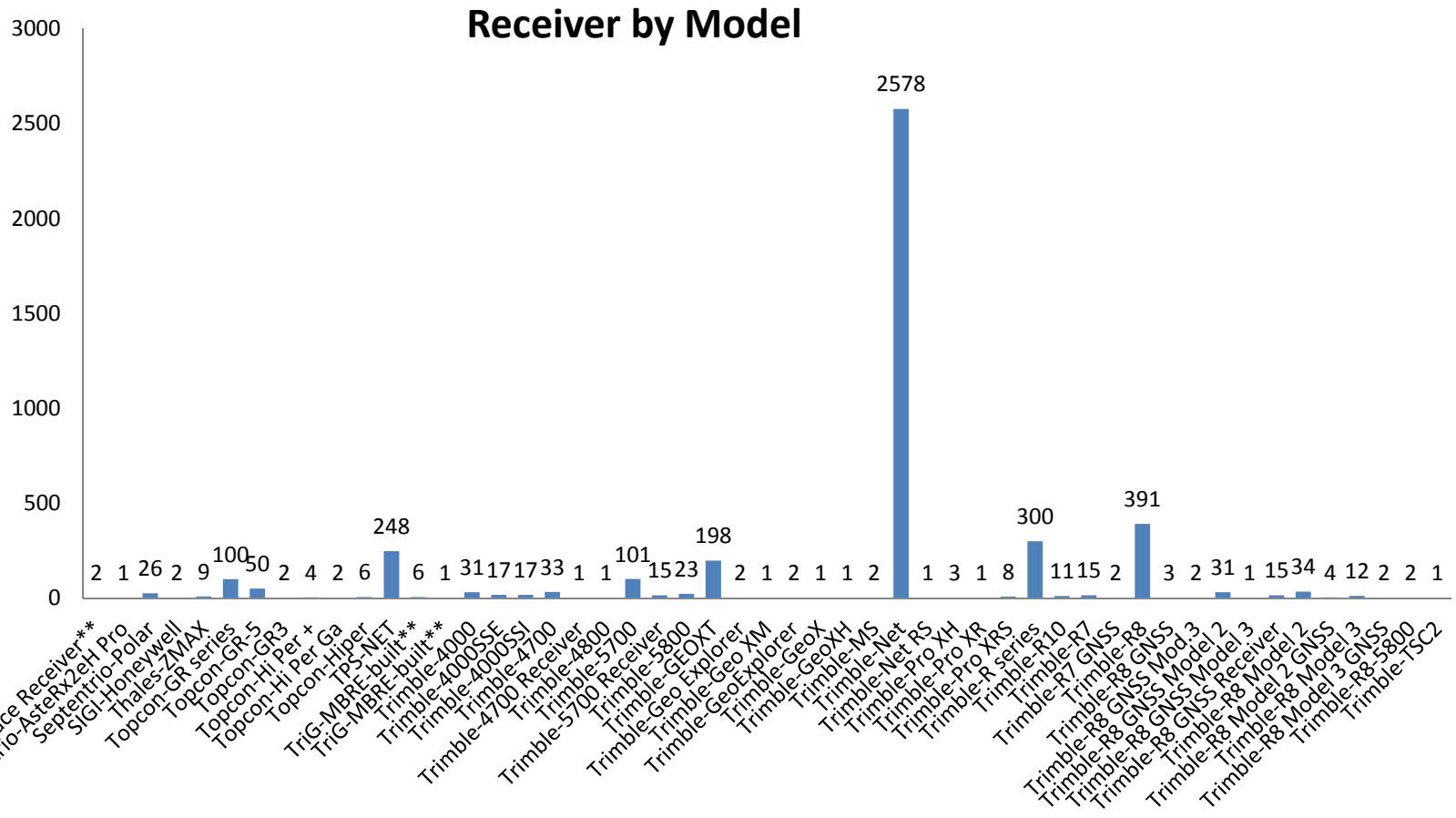
High Precision (HPR) [2/2] by Manufacturer and Model



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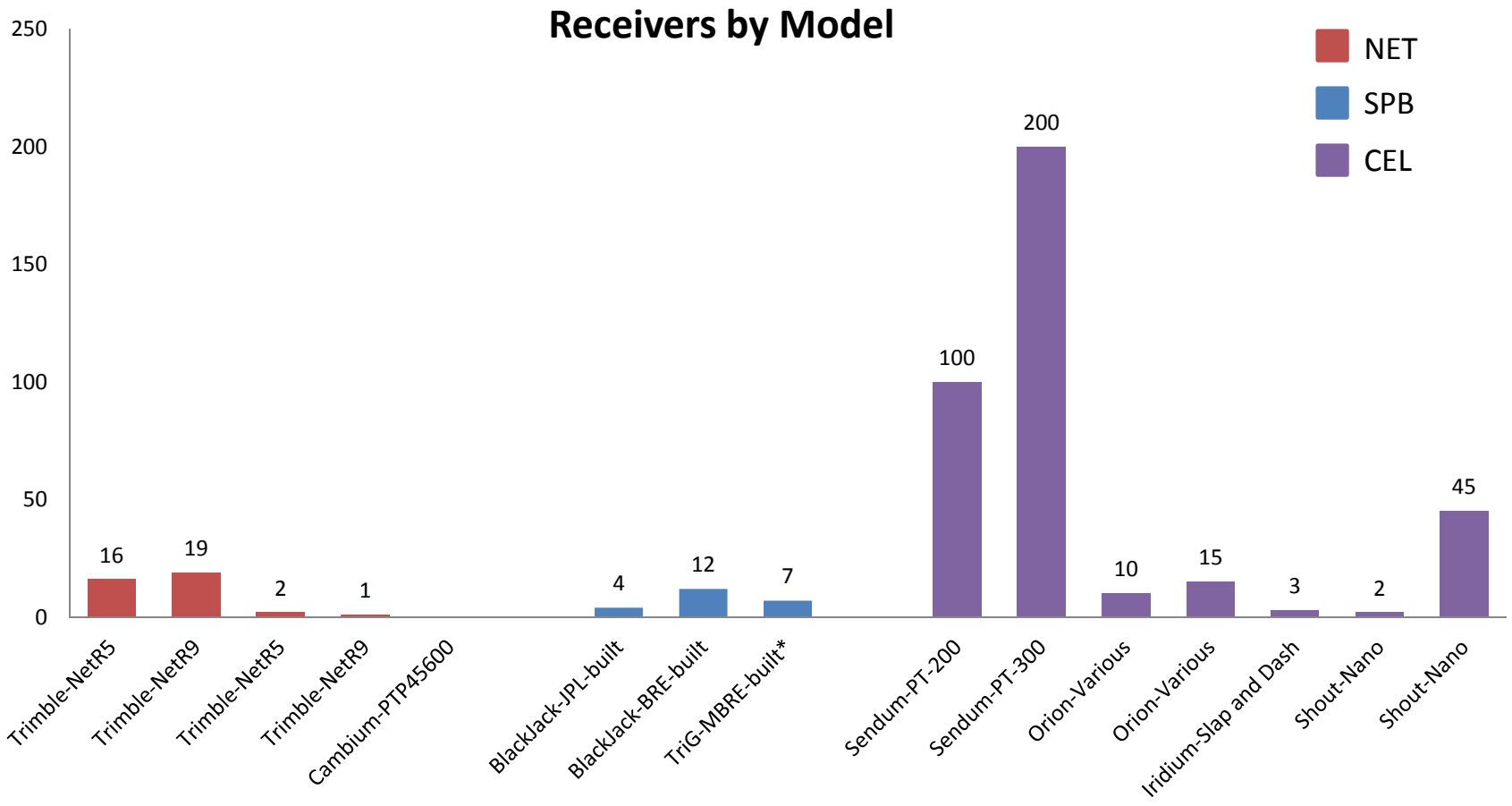

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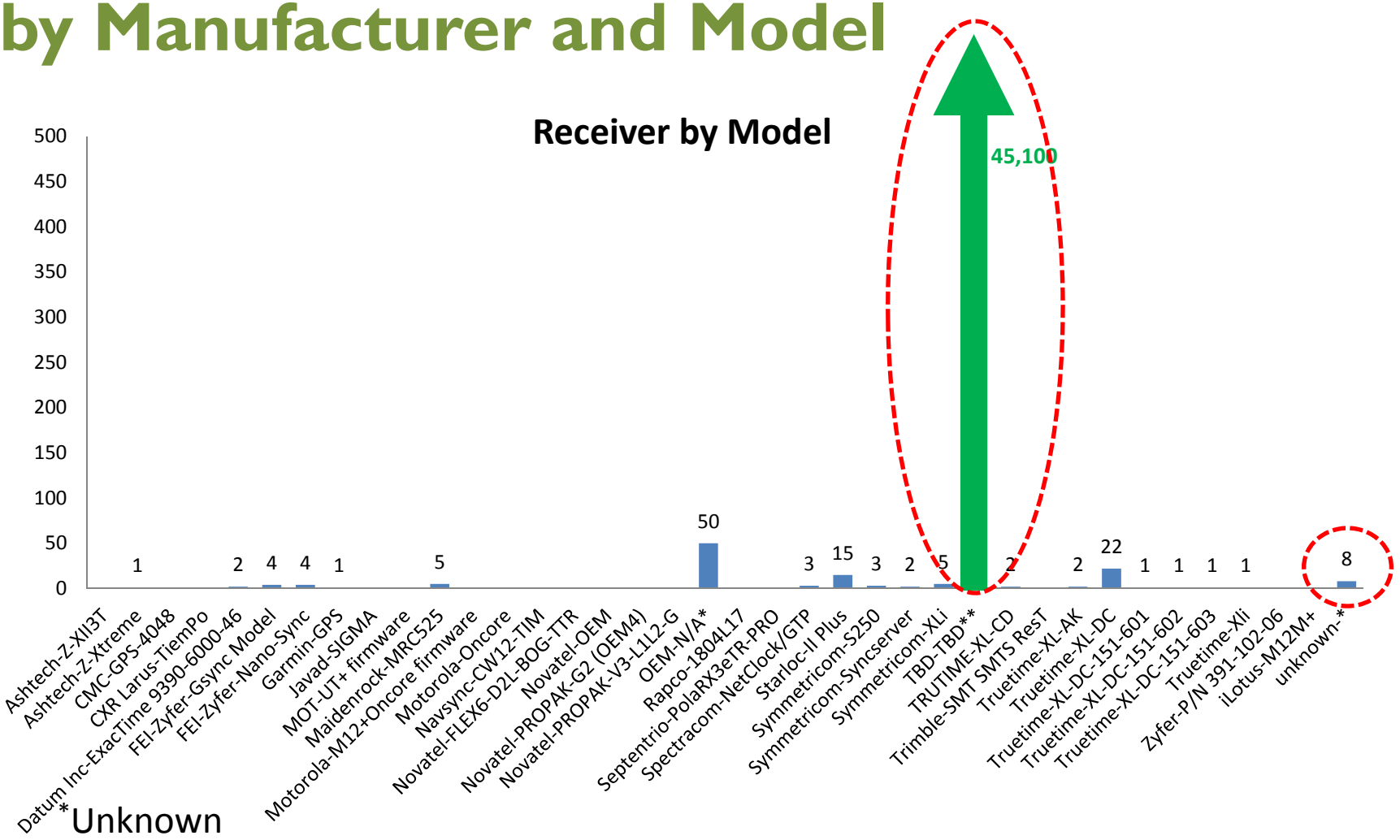
Timing (TIM) by Manufacturer and Model



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