

The Invisible Radar Triangle



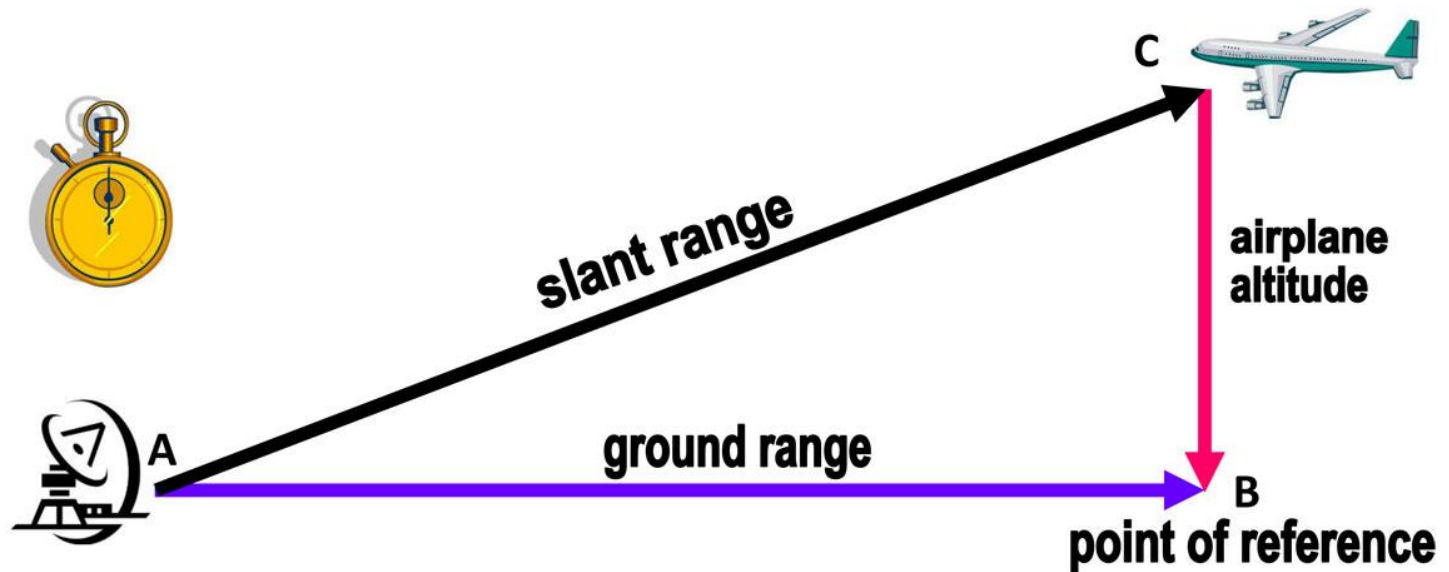
Image source: US Air Force, http://www.af.mil/photos/media_search.asp?q=isar

What is radar imaging?

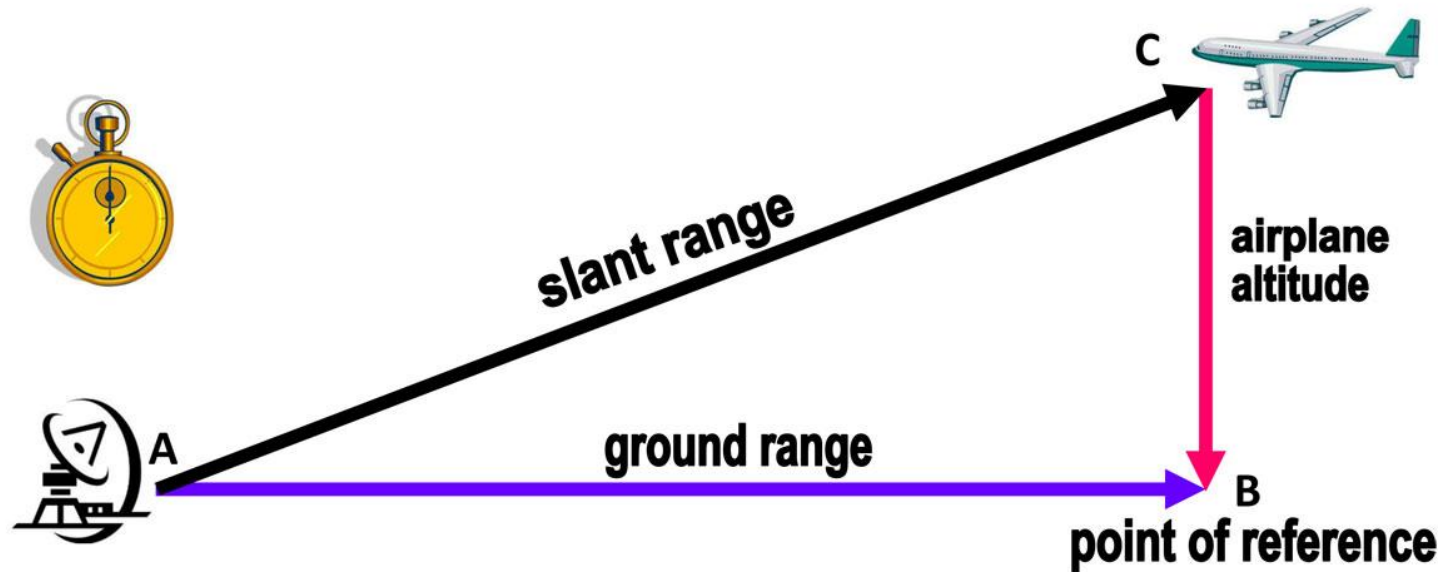
- Radar imaging is used to detect objects that are far away.
- Many different types of radar imaging have been created, but in this activity, we will look at **inverse synthetic aperture radar (ISAR)**.
- ISAR creates images of objects (**targets**) that are constantly **moving** (such as airplanes, cars, planets, etc.).



What about the triangle?



- This drawing illustrates a radar imaging scenario. ↖
- The distance from the radar to the target is the **slant range**.
- The horizontal distance from the radar to a point of reference on the ground under the target is the **ground range**.
- The slant range, ground range and airplane's altitude form an *invisible right triangle*. Do you see it?



Engineers use this invisible triangle and different equations to calculate the **distance**, **direction** and **elevation angle** of the target.

Why do we need radar imaging?

- ISAR radar imaging is mainly used by government agencies for **surveillance**.
- Engineers have designed many radar systems for **many different uses**.
- For example, NASA uses different kinds of radars to **study the Earth, other planets and space**.
- Radars are also used to monitor **weather**.

Radar imaging simulations

- To continually improve existing radar imaging techniques, engineers have developed radar imaging **simulators**.
- A radar imaging simulator uses a **three-dimensional model** of the target being studied to generate radar images and adjust parameters until the desired image quality is achieved.
- **Similarity** and **scaling** are used to create three-dimensional scale models of targets.



Image source: US Air Force, model of E-3, [http://www.af.mil/photos/media_search.asp?q=radar imaging simulation&page=36](http://www.af.mil/photos/media_search.asp?q=radar+imaging+simulation&page=36)

Imagine...



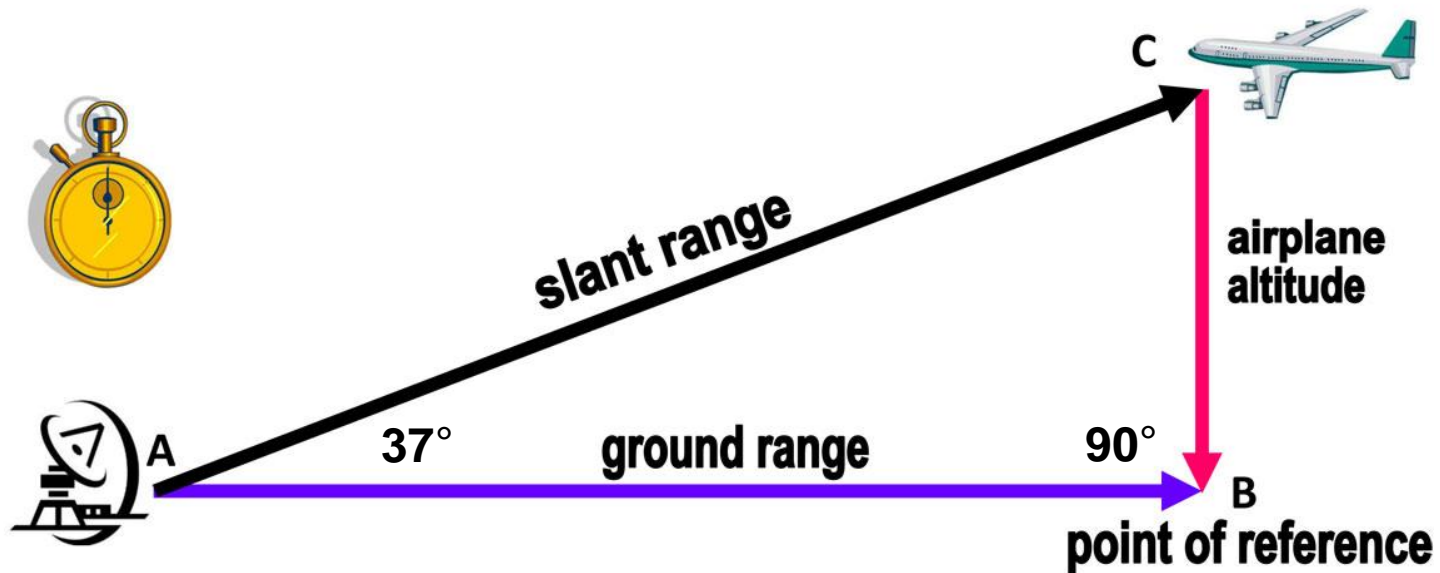
Imagine you are an army soldier who monitors radar systems at a military base. You are asked to make a presentation to a group of people describing how radar imagining is done. **Your audience is not familiar with radar imaging.**

You decide to use **a model** to help your audience better understand your presentation. Your model must be similar to the one shown in the presentation.



Image source: US Air Force,
http://www.af.mil/photos/media_search.asp?q=isar

- **How can a model help you present this concept?**



You know the angle formed by the ground range and the airplane's altitude is **90 degrees**.

You want to use an elevation angle of **37 degrees** (formed by the ground range and slant range).

- How can you determine the third angle in the triangle?
- How can you make a realistic model of the scenario?
- How can the concept of similar figures help you construct a proportional model to make it more realistic?

Let's Plan

- First, design your model on paper.
- When you are done, show it to me.

Infrared range sensor

- Radars send radio waves to a target, the waves reflect back and are stored and processed to produce an image.
- **Engineers use equations to calculate the distance between the radar and the airplane.**
- In our activity, we will use an **infrared range sensor** and a **multimeter** to calculate the distance between the radar and the airplane.
- You will work in your groups to make and calibrate your sensors.

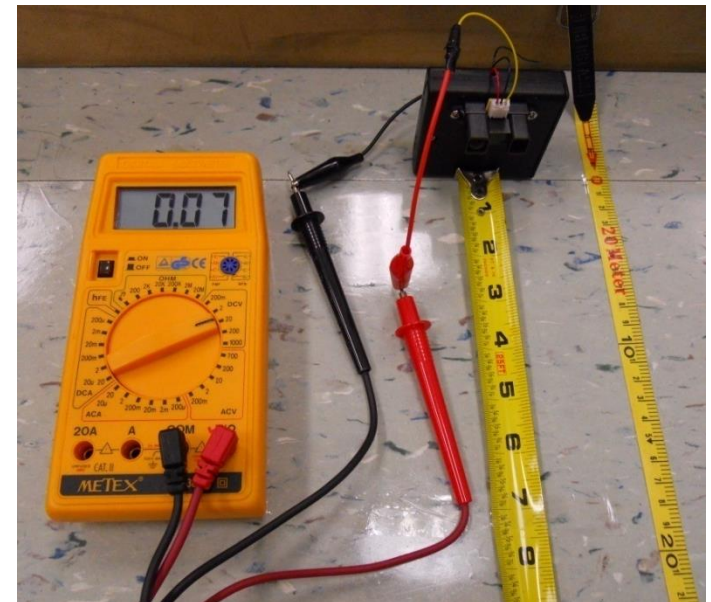


Image source: 2012 RET-ENET Program, The University of Texas-Pan American



References

- Wolff, Christian. “*Synthetic Aperture Radar.*” Accessed July 6, 2012. (inspiration for triangle diagram) <http://www.radartutorial.eu/20.airborne/ab07.en.html#this>
- “*Video Gallery.*” NASA. Accessed July 6, 2012. <http://www.nasa.gov/multimedia/videogallery/index.html>