

# GPS: Basic Principles

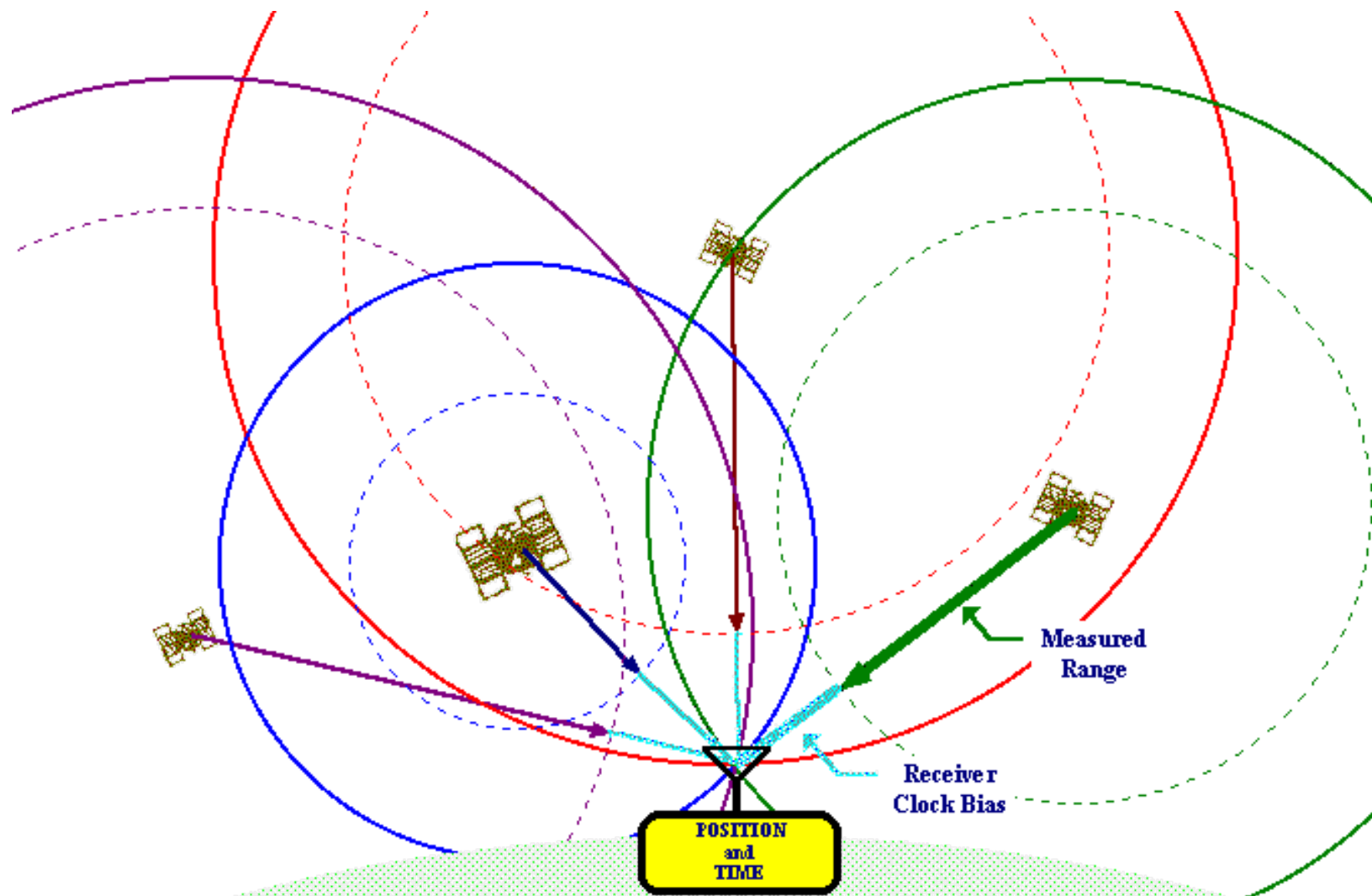
*Michael Zoltowski*  
*Addendum to ECE 538*

Department of Electrical and Computer Engineering  
*Session 5*

**PURDUE**  
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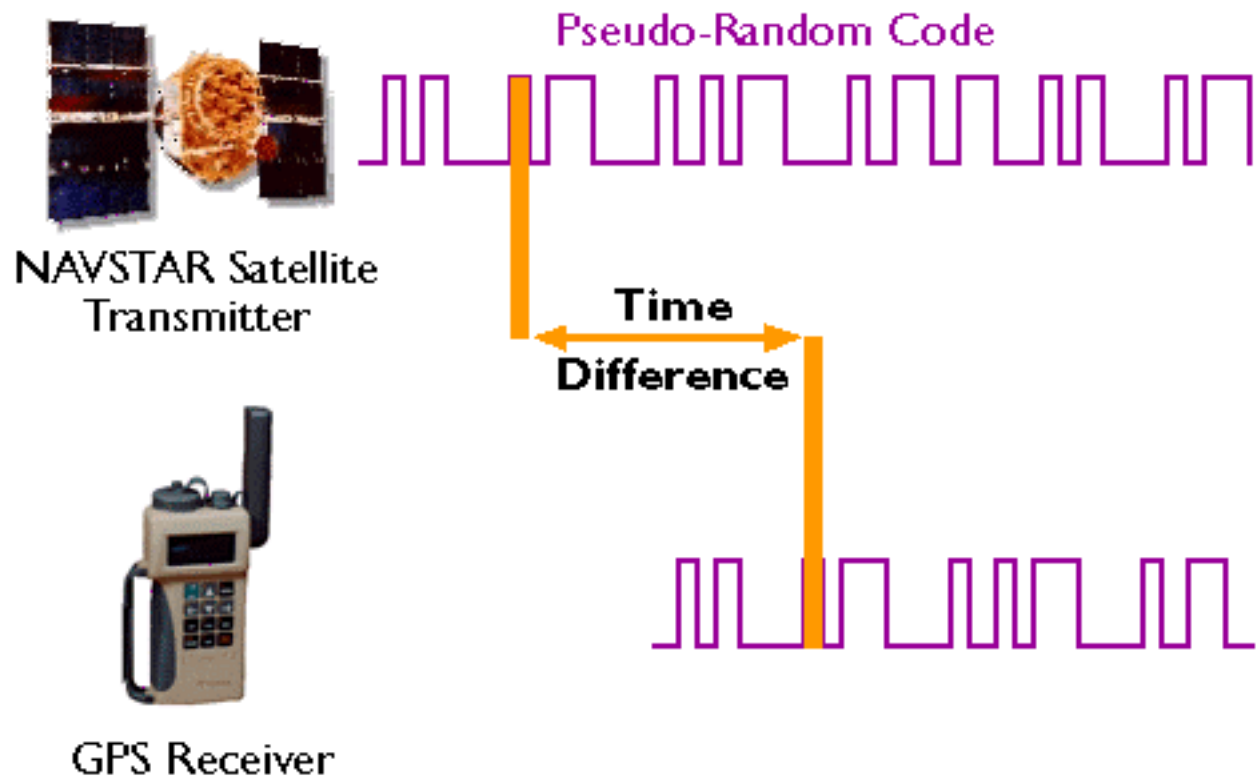
**The GPS Navigation Solution**  
 The estimated ranges to each satellite intersect within a small region when the receiver clock bias is correctly estimated and added to each measured relative range.

$$\left(x_{\text{iss}} - x_1\right)^2 + \left(y_{\text{iss}} - y_1\right)^2 + \left(z_{\text{iss}} - z_1\right)^2 = \left(r_1 - \varepsilon_{\text{clock}}\right)^2$$

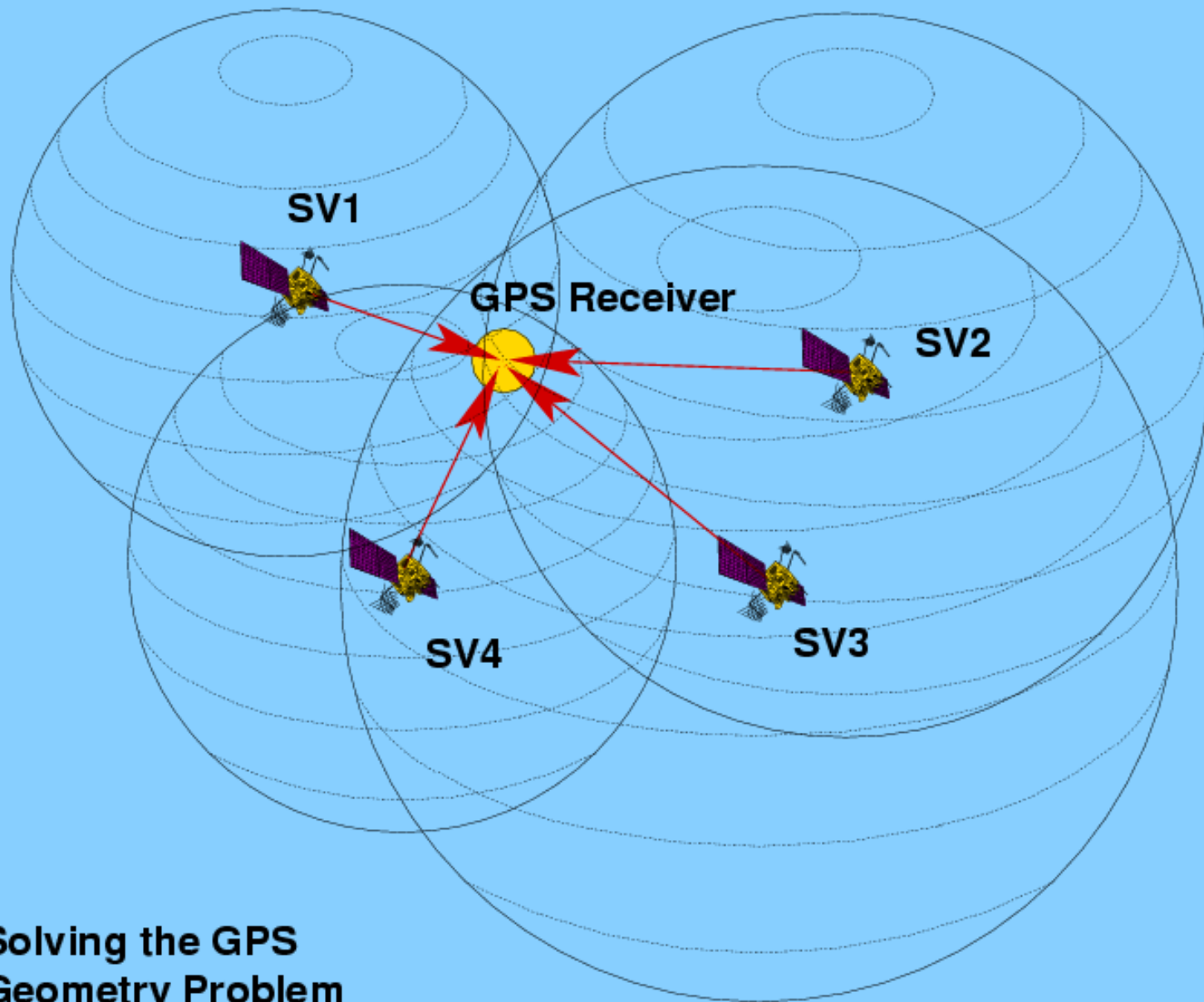
$$\left(x_{\text{iss}} - x_2\right)^2 + \left(y_{\text{iss}} - y_2\right)^2 + \left(z_{\text{iss}} - z_2\right)^2 = \left(r_2 - \varepsilon_{\text{clock}}\right)^2$$

$$\left(x_{\text{iss}} - x_3\right)^2 + \left(y_{\text{iss}} - y_3\right)^2 + \left(z_{\text{iss}} - z_3\right)^2 = \left(r_3 - \varepsilon_{\text{clock}}\right)^2$$

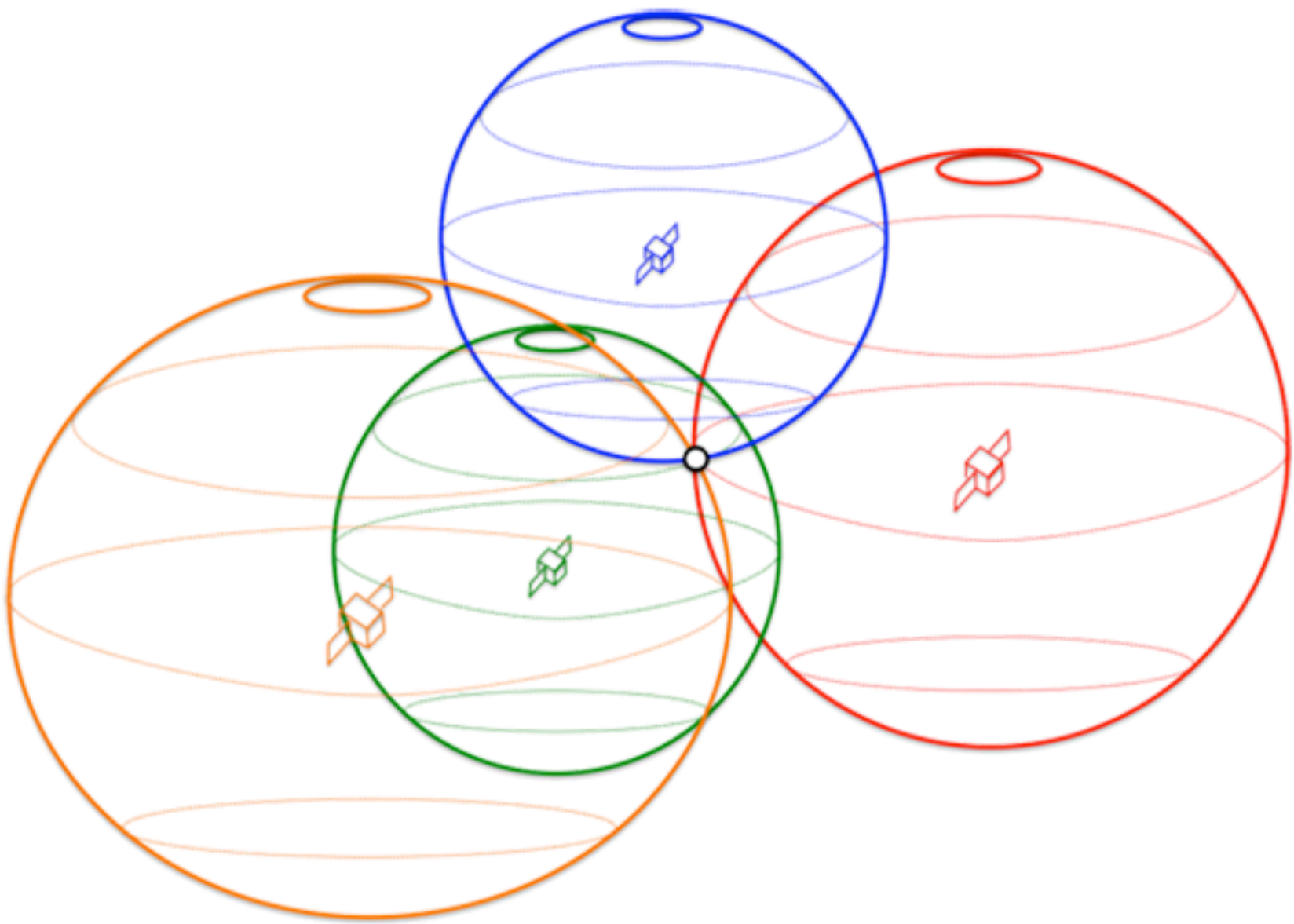
$$\left(x_{\text{iss}} - x_4\right)^2 + \left(y_{\text{iss}} - y_4\right)^2 + \left(z_{\text{iss}} - z_4\right)^2 = \left(r_4 - \varepsilon_{\text{clock}}\right)^2$$

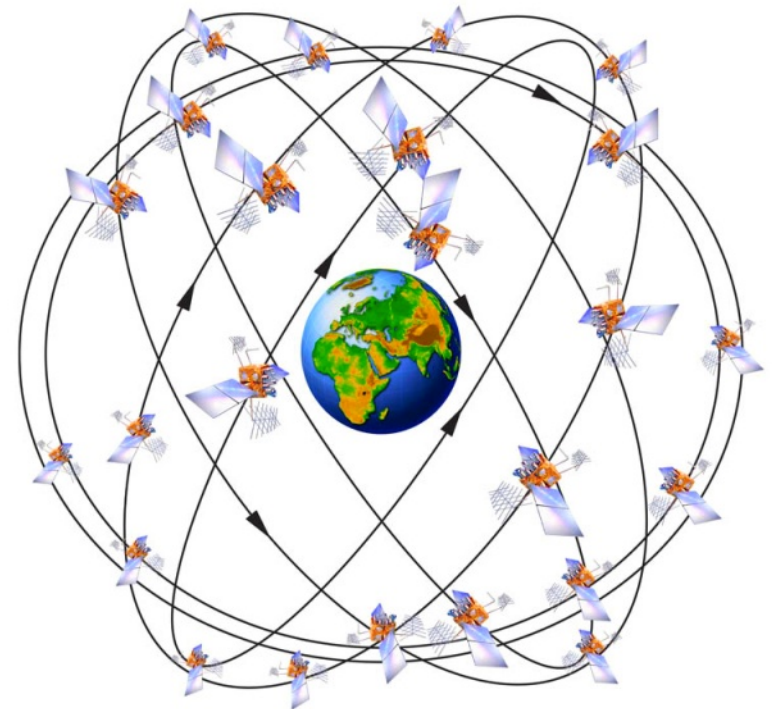
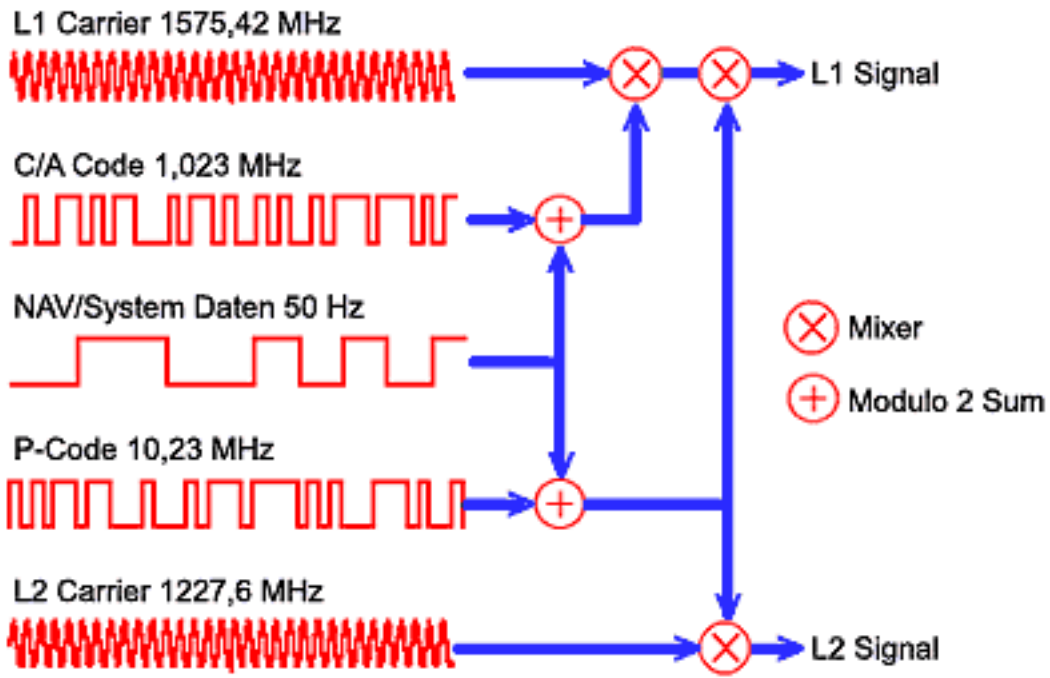


**Distance = Speed of Light • Time Difference**



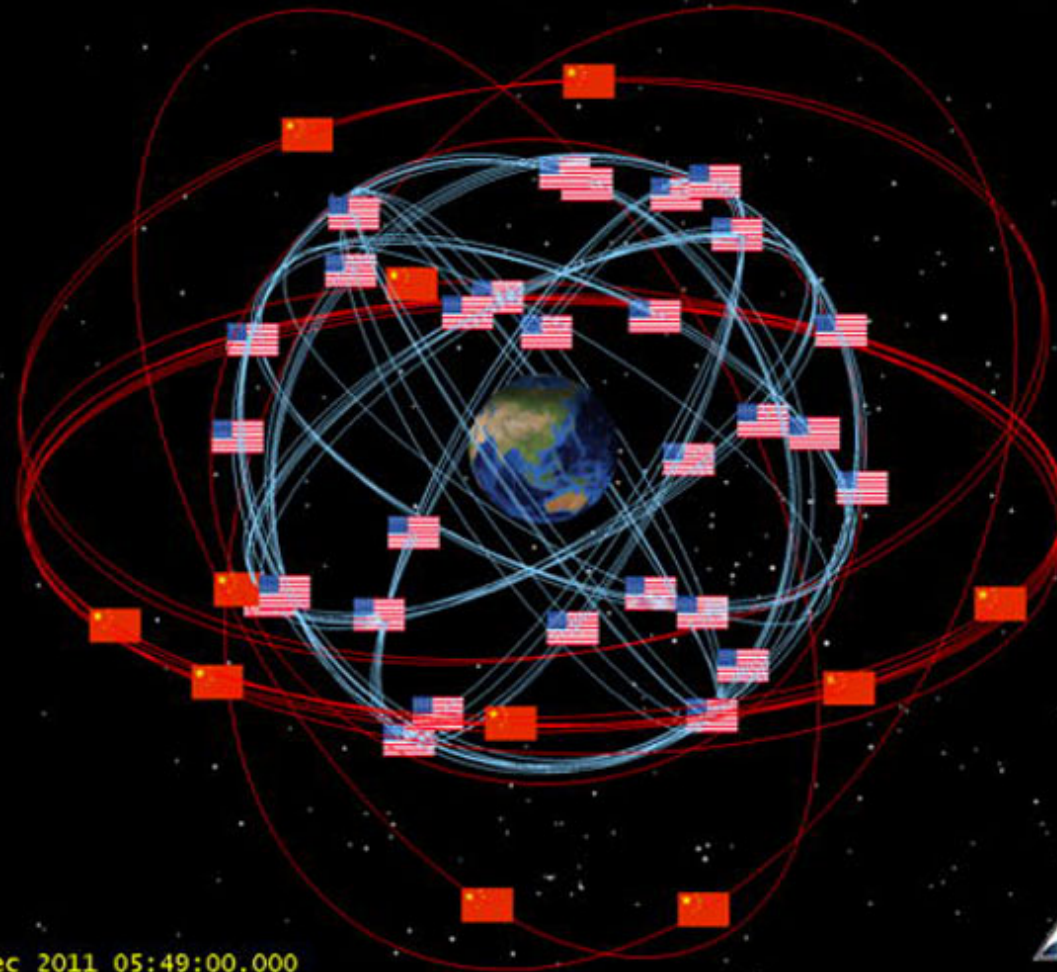
**Solving the GPS  
Geometry Problem**







US GPS Navigation Satellites  
Chinese Beidou Navigation Satellites



28 Dec 2011 05:49:00.000



**Figure 1**



# GPS Data

- **Data File**

- range (pseudorange) measurement derived from code synchronization,
  - measured phase of carrier frequency L1 and L2,
  - and (optional) range rate (Doppler)
- **Navigation Message** (broadcast ephemeris) - provides information about satellite orbits, time, clock errors and ionospheric model to remove the ionospheric delay (error) from the observations
  - **Provided in binary-receiver dependent format**
  - Usually converted to **RINEX** - Receiver Independent Exchange format (ASCII file)