

Indoor positioning system

Author: Velcherean Raul

Supervisor: asis.eng.

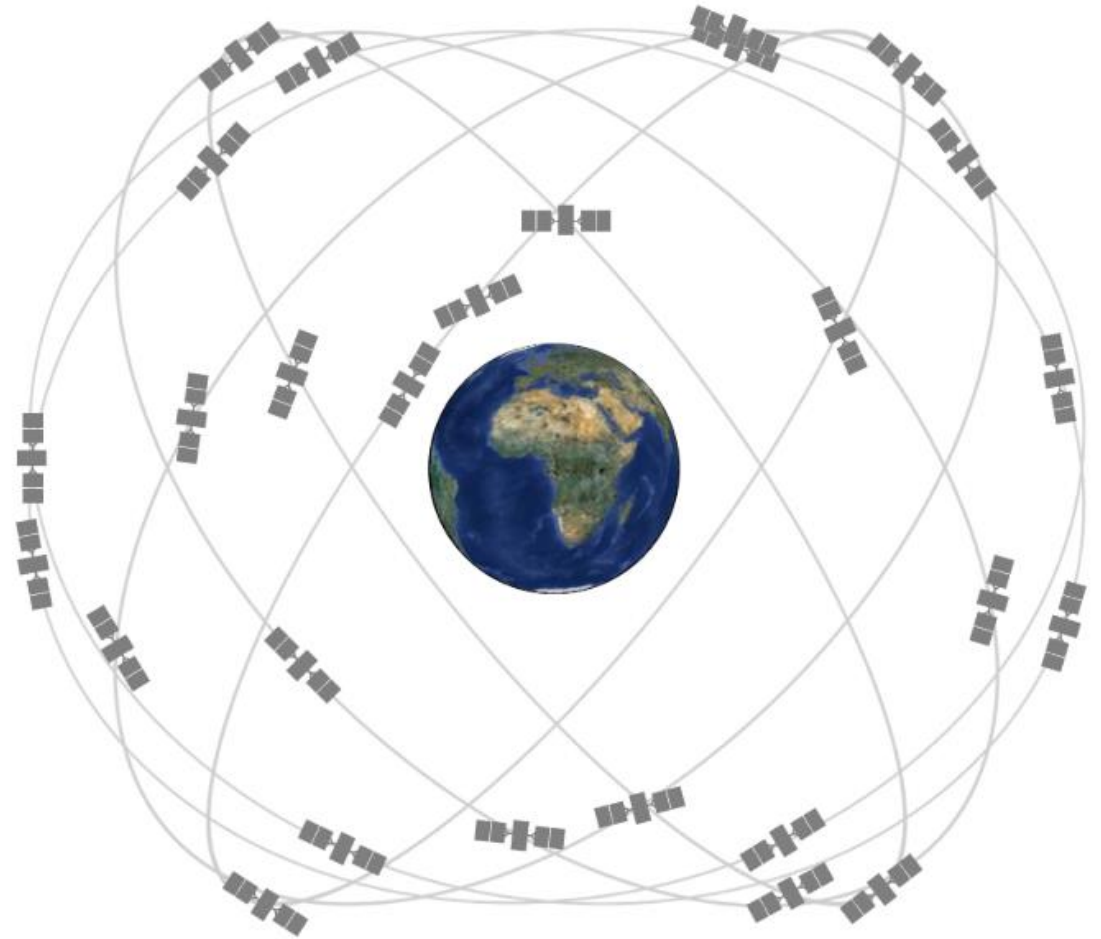
Harja Gabriel



What is a positioning system?

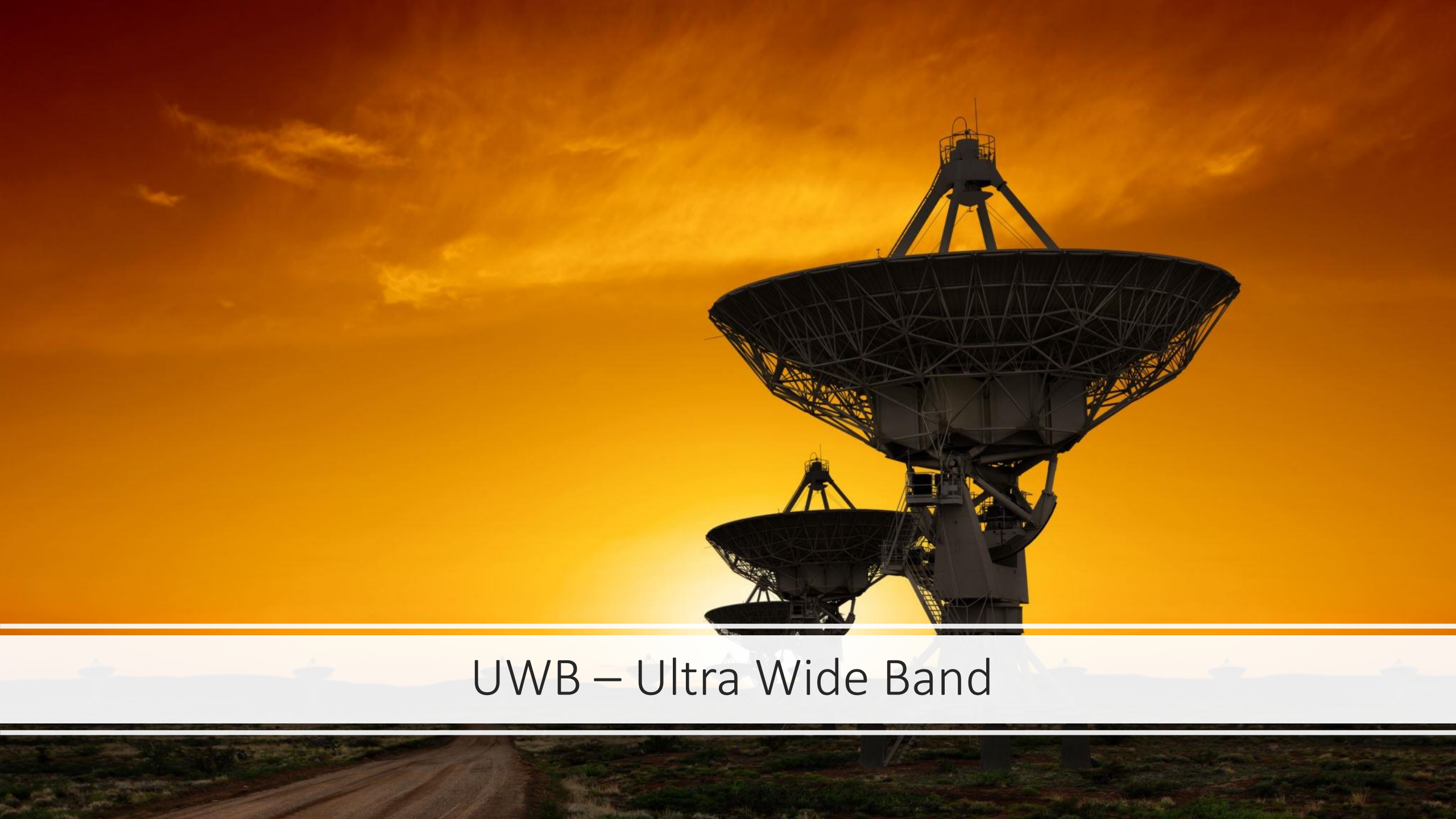


Global Positioning System



Comparison of IPS technologies

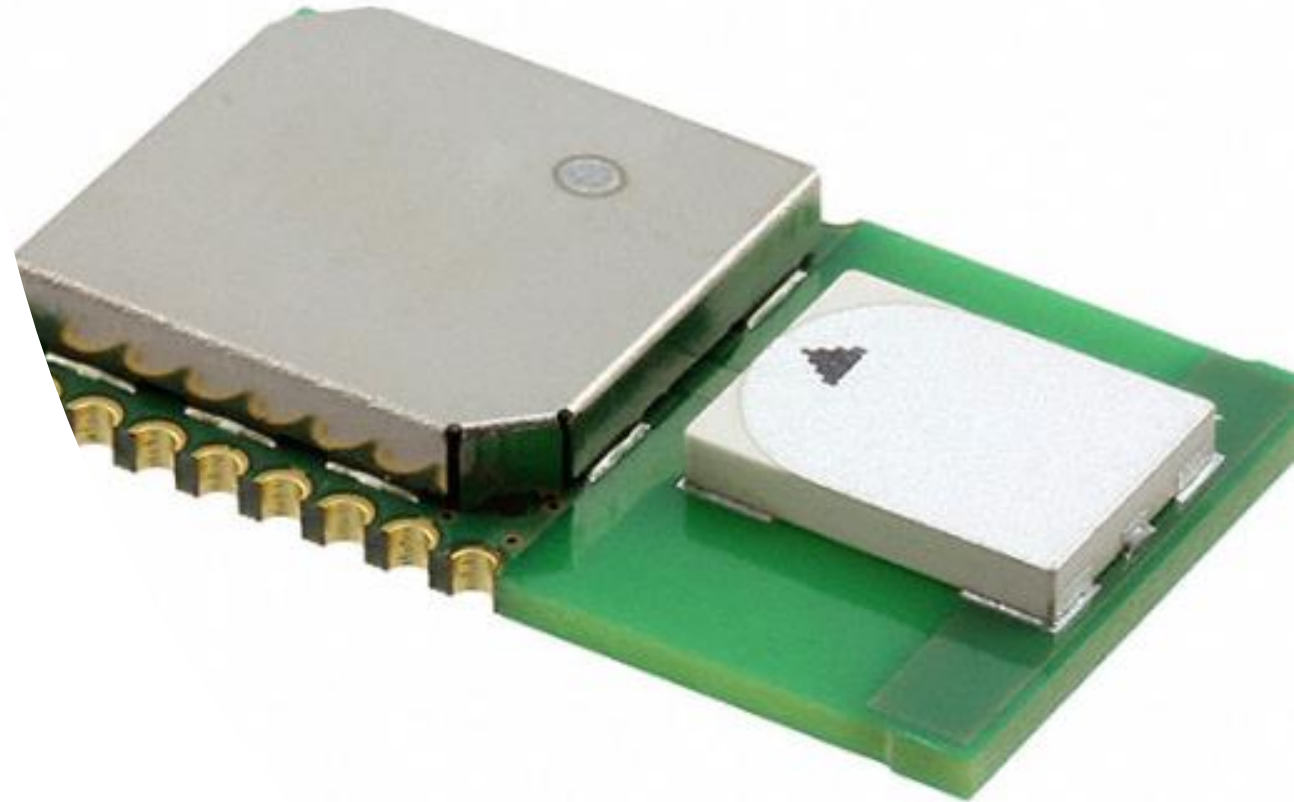
IPS	Technology	Accuracy	Cost (installation/ unit)	Advantages	Disadvantages	Complexity
RADAR	WiFi	2-3 m	L/L	Low price, existing infrastructure	Low accuracy, complex system	Medium
Ekahau	WiFi	1-3 m	H/L	Existing infrastructure, good mapping software	Expensive mapping software	Low
LANDMARC	RFID	2 m	H/L	Very cheap user units	Locating delay 7.5 s	Medium
Active Bat	Ultrasound	3 cm	H/L	Cheap user units, very precise	Requires a lot of beacons, medium battery life	High
Lok8	Ultrasound	10 cm	L/L	Smartphone user units, precise	Requires new infrastructure in every room	Medium
Topaz	Bluetooth	2 m	L/L	Low price	Locating delay 15-30 s	Medium
iBeacon	Bluetooth	0.5-3 m	H/L	Smartphone user units, ease of access	Requires a lot of beacons for better precision	Low
Beauregard et al.	Inertial	0.74-2.5 m	L/L	Cheap, map can be added post-hoc	Requires a detailed map for better precision	Medium
Ubisense	Ultra-wideband	15 cm	H/H	Very precise, very robust	Expensive installation and units	High



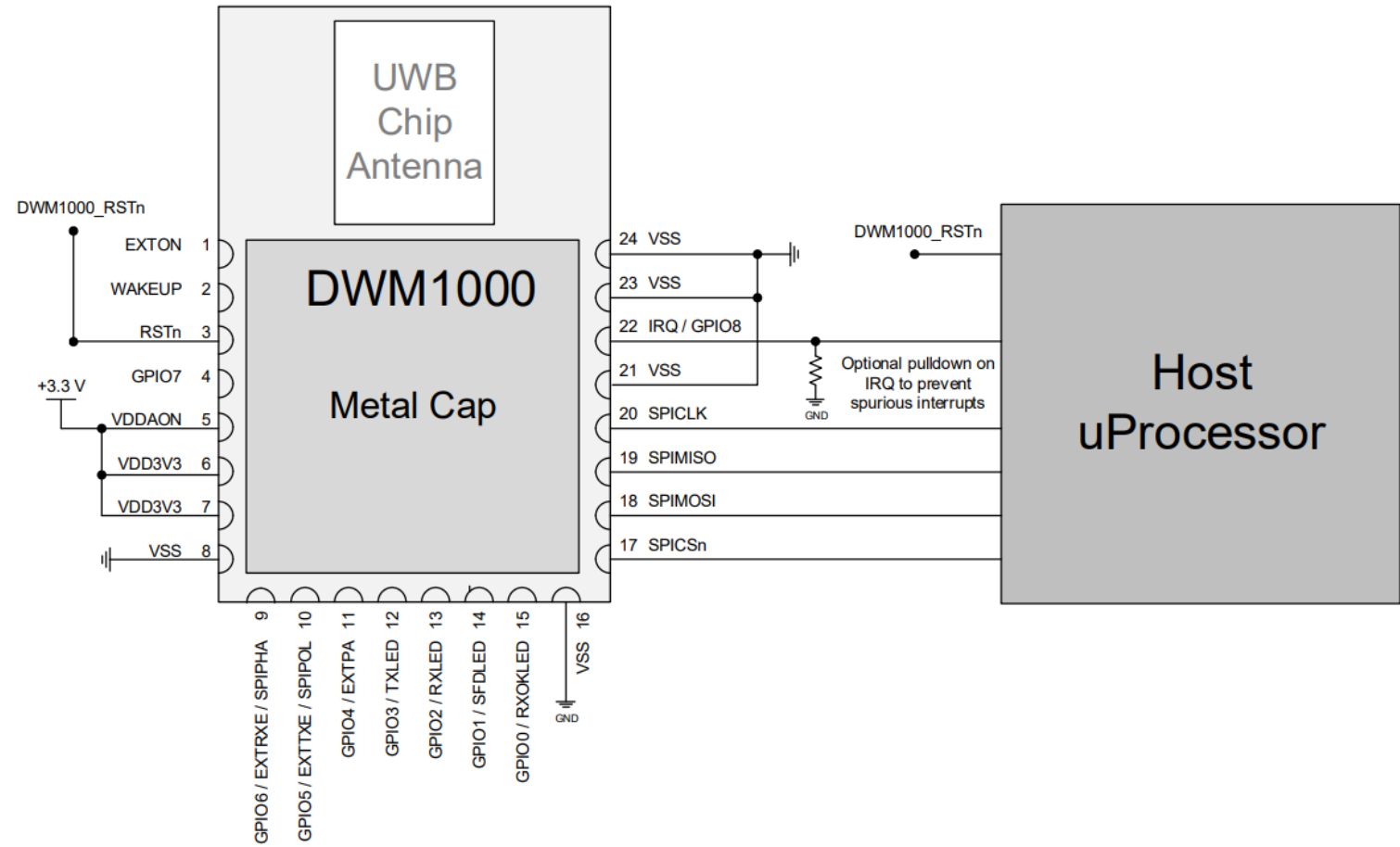
UWB – Ultra Wide Band

DWM1000

- Transceiver IC with antenna, all RF circuitry, power management and clock circuitry all in one
- 4 RF bands (3.5GHz to 6.5 GHz)
- Low power consumption
- Data rates: 110 kbps, 850 kbps, 6.8 Mbps
- 63.8976 GHz sampling clock used for ranging (15.65 ps period)
- 23 mm x 13 mm x 2.9 mm

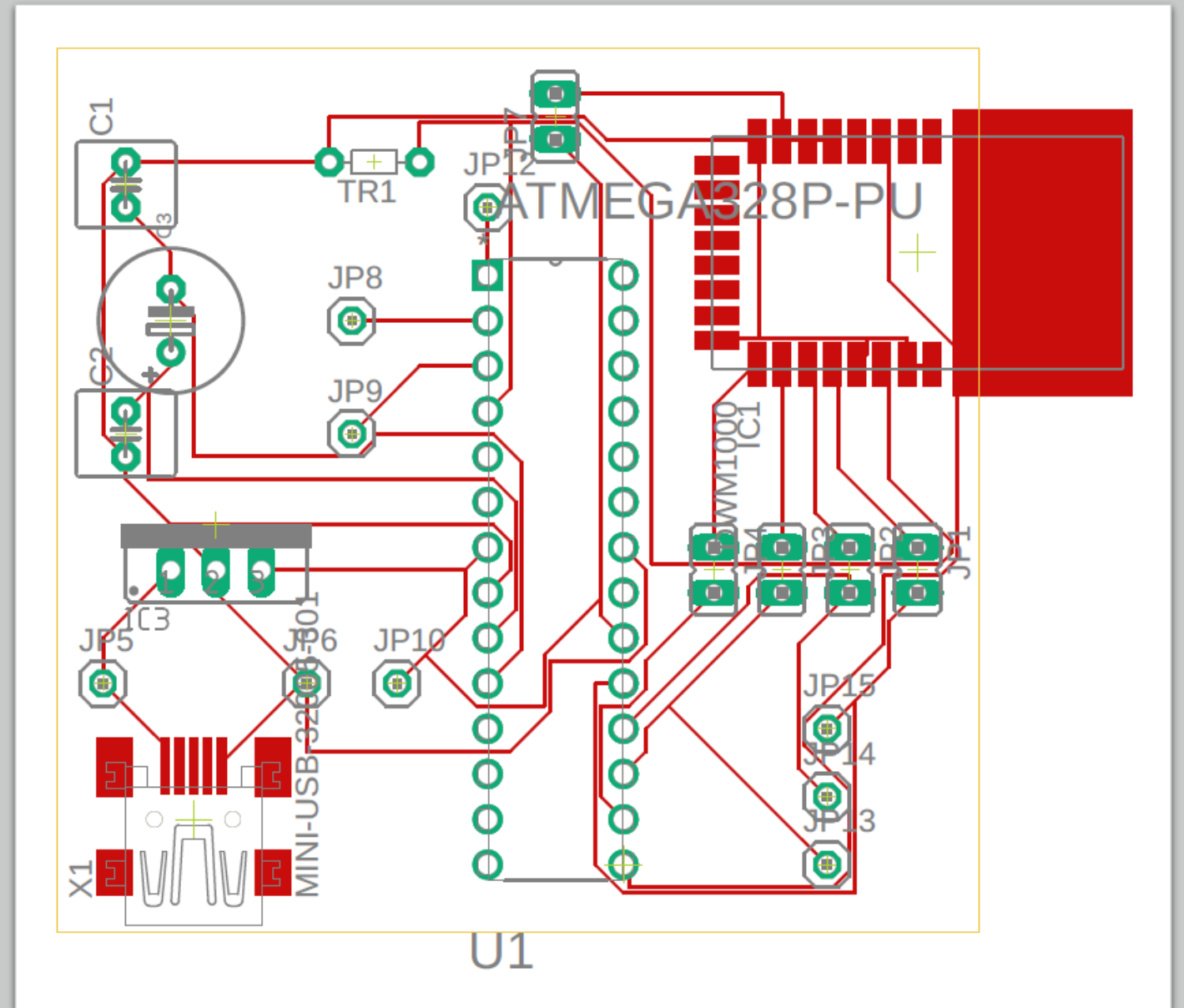


Microcontroller – DWM1000 connection

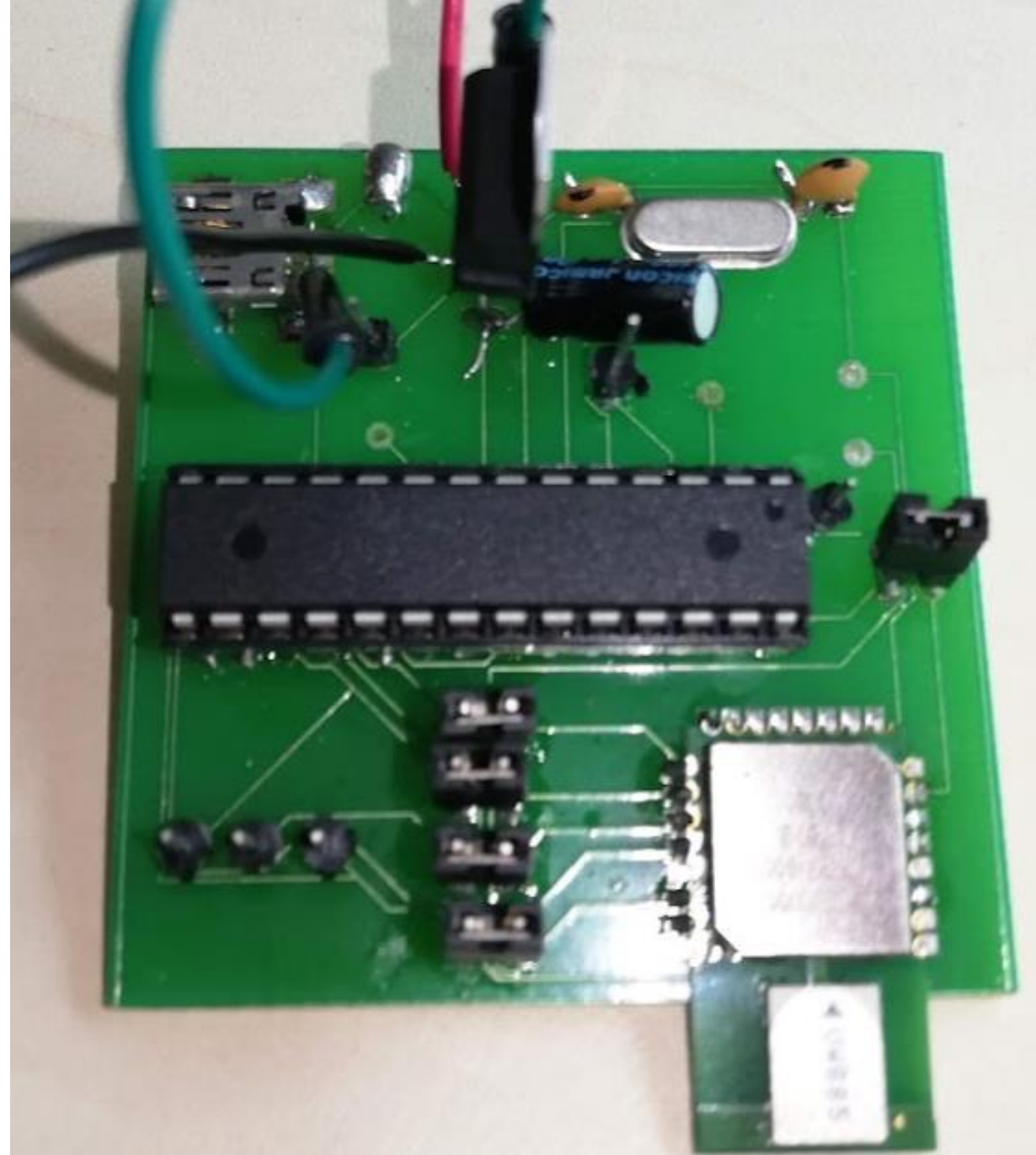


Design of the PCB

- DWM1000
- ATmega328P
- 3.3V voltage regulator
- Mother mini-USB connector
- Capacitors, Oscillator, Pins

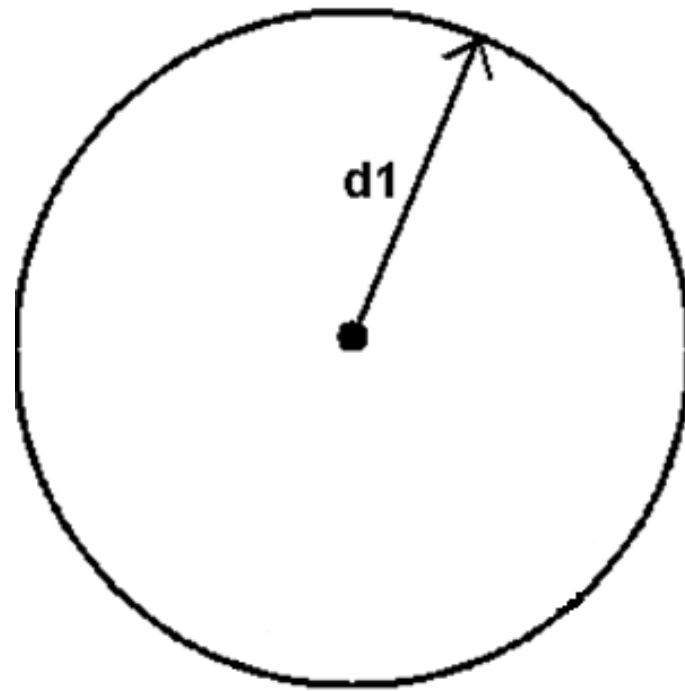


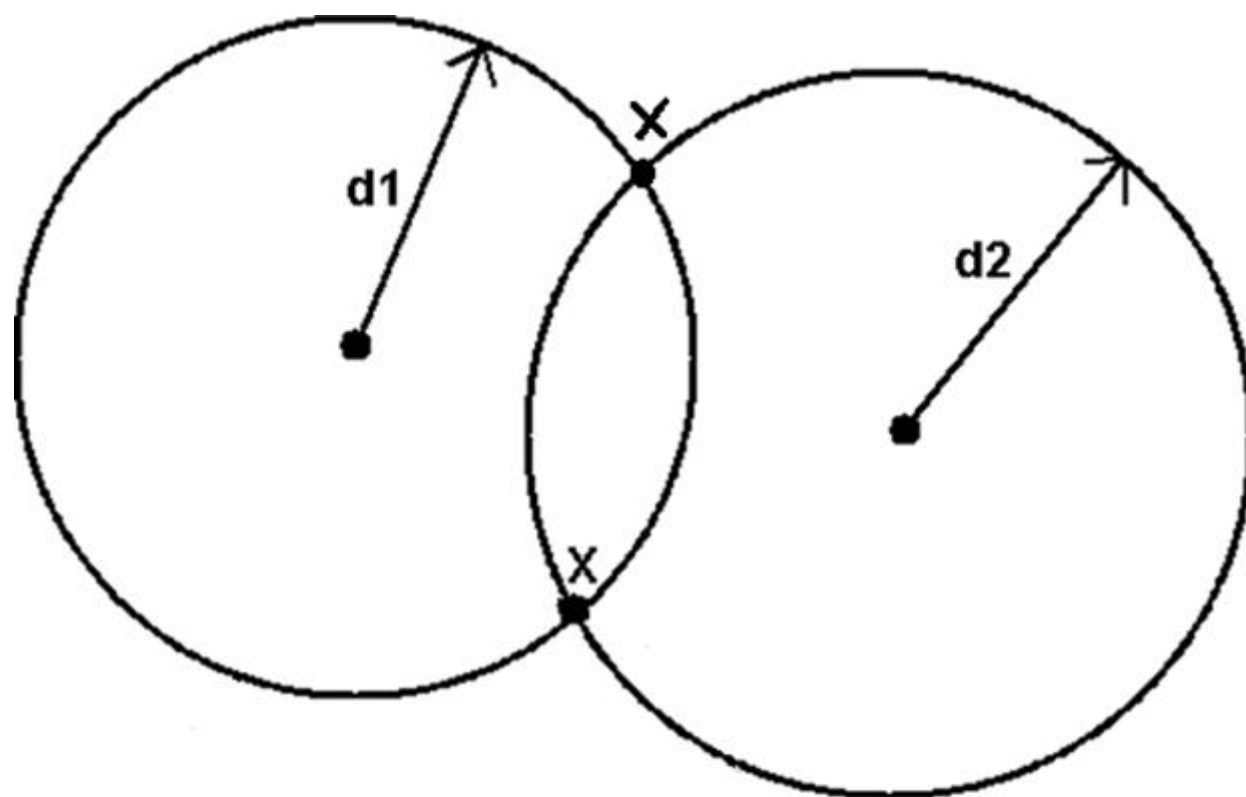
Final form

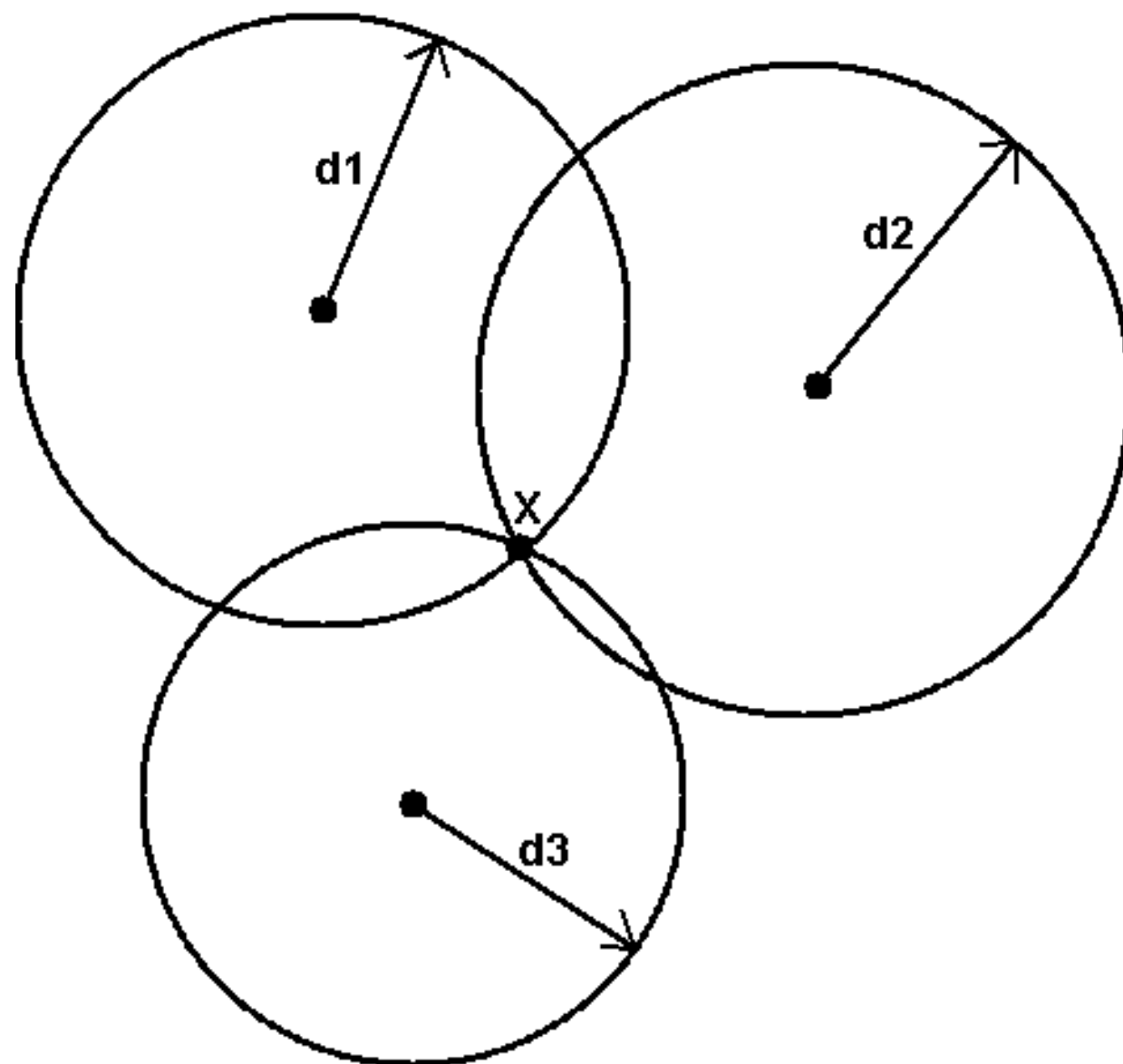




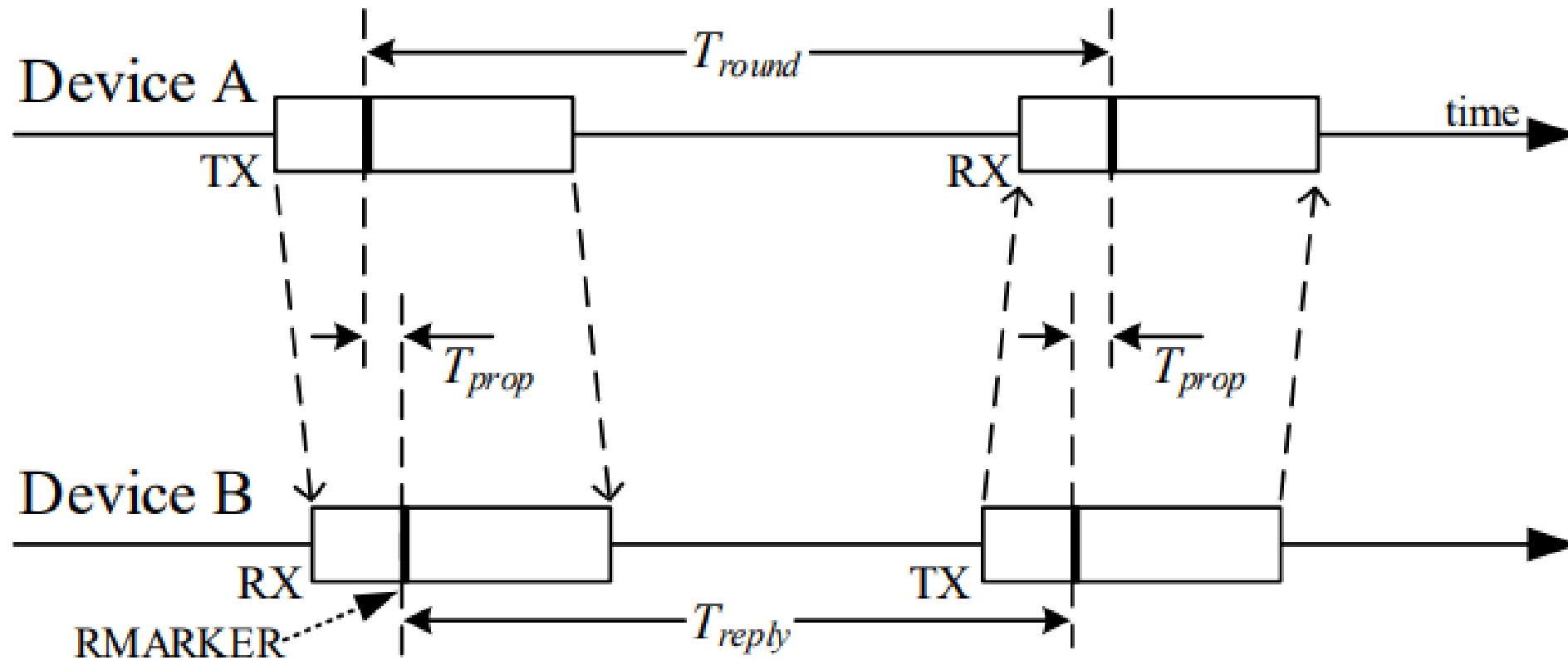
Trilateration





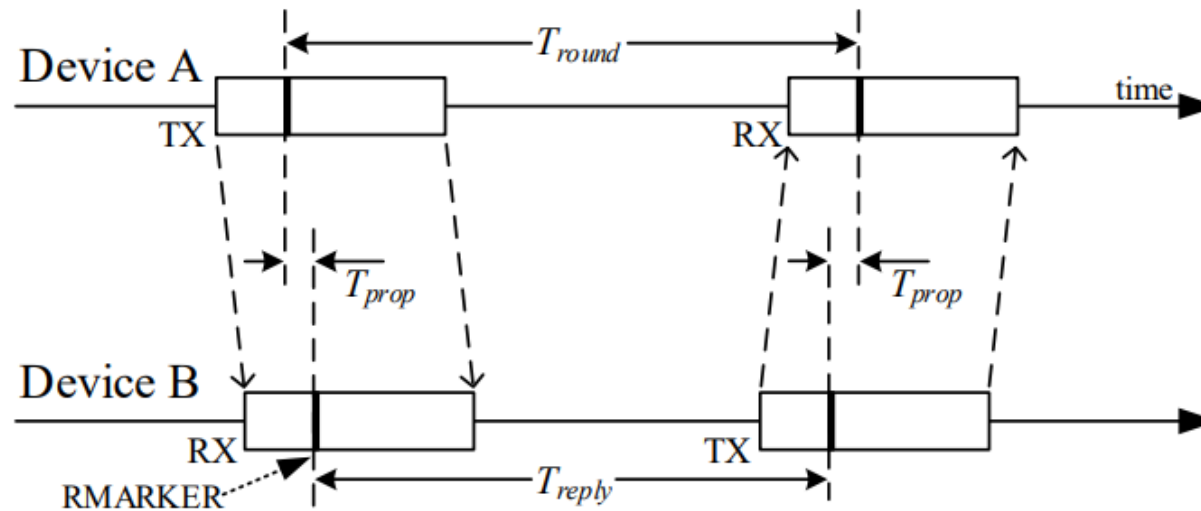


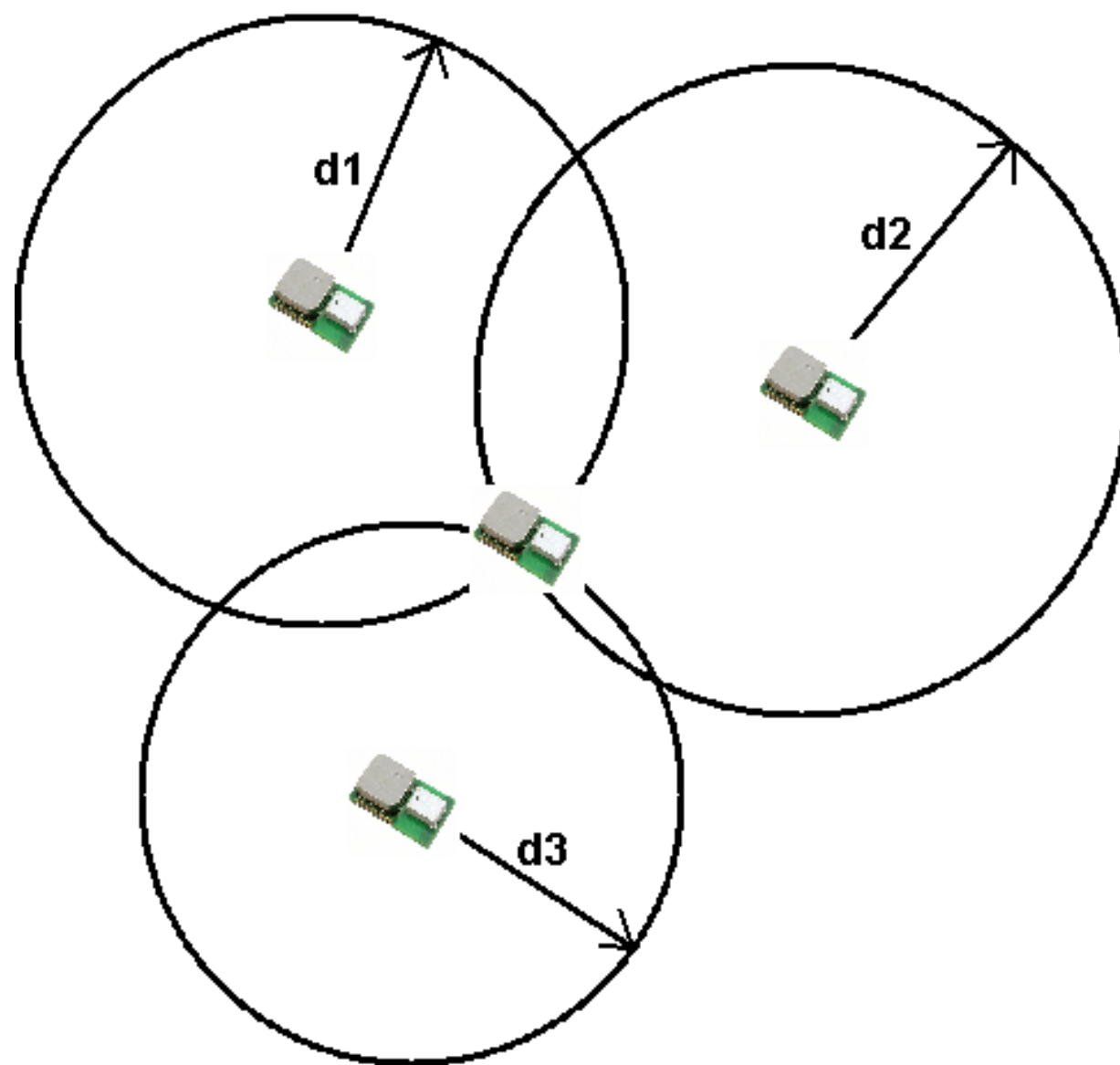
Single-sided two-way ranging

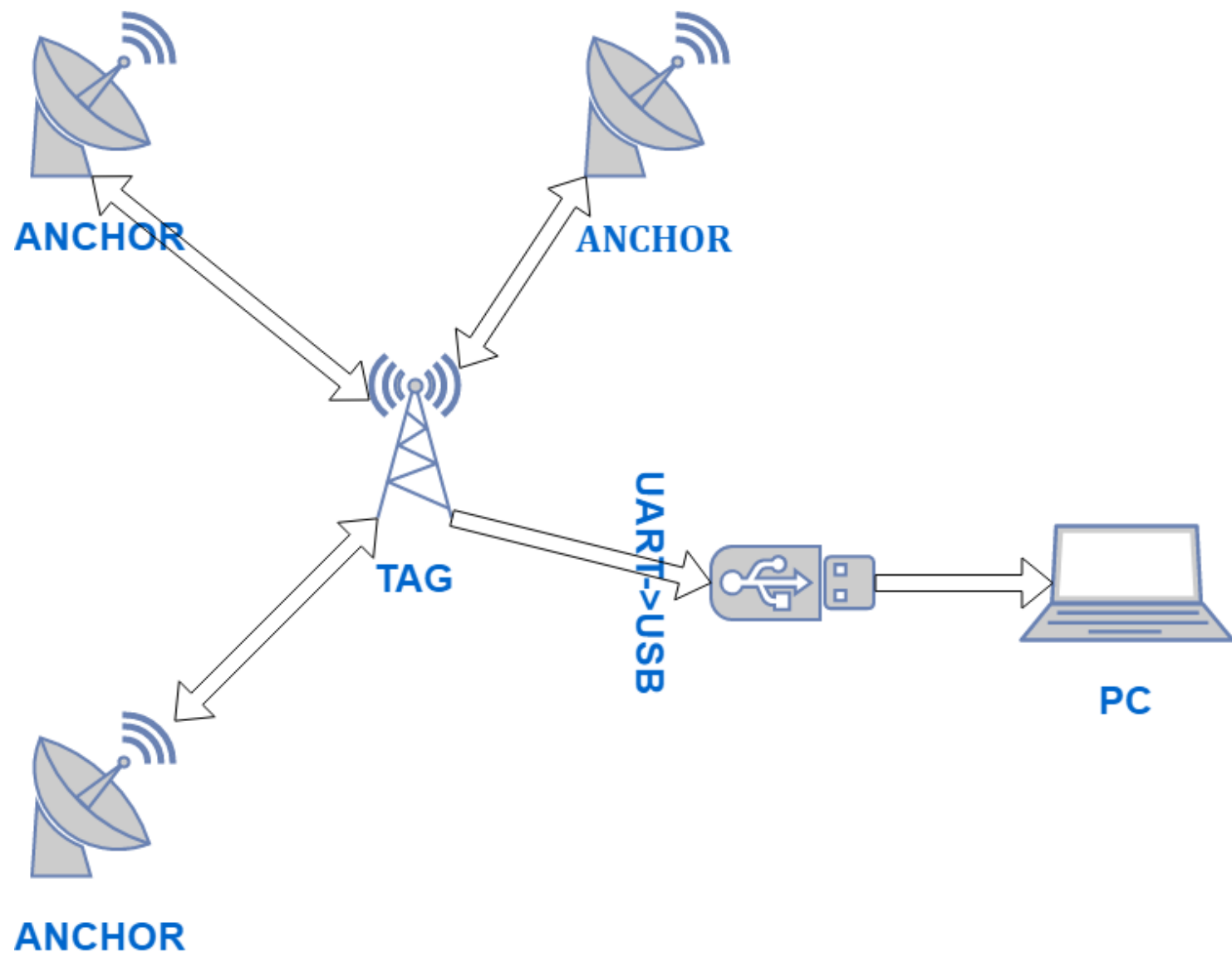


Single-sided two-way ranging

$$\hat{T}_{prop} = \frac{1}{2}(T_{round} - T_{reply})$$

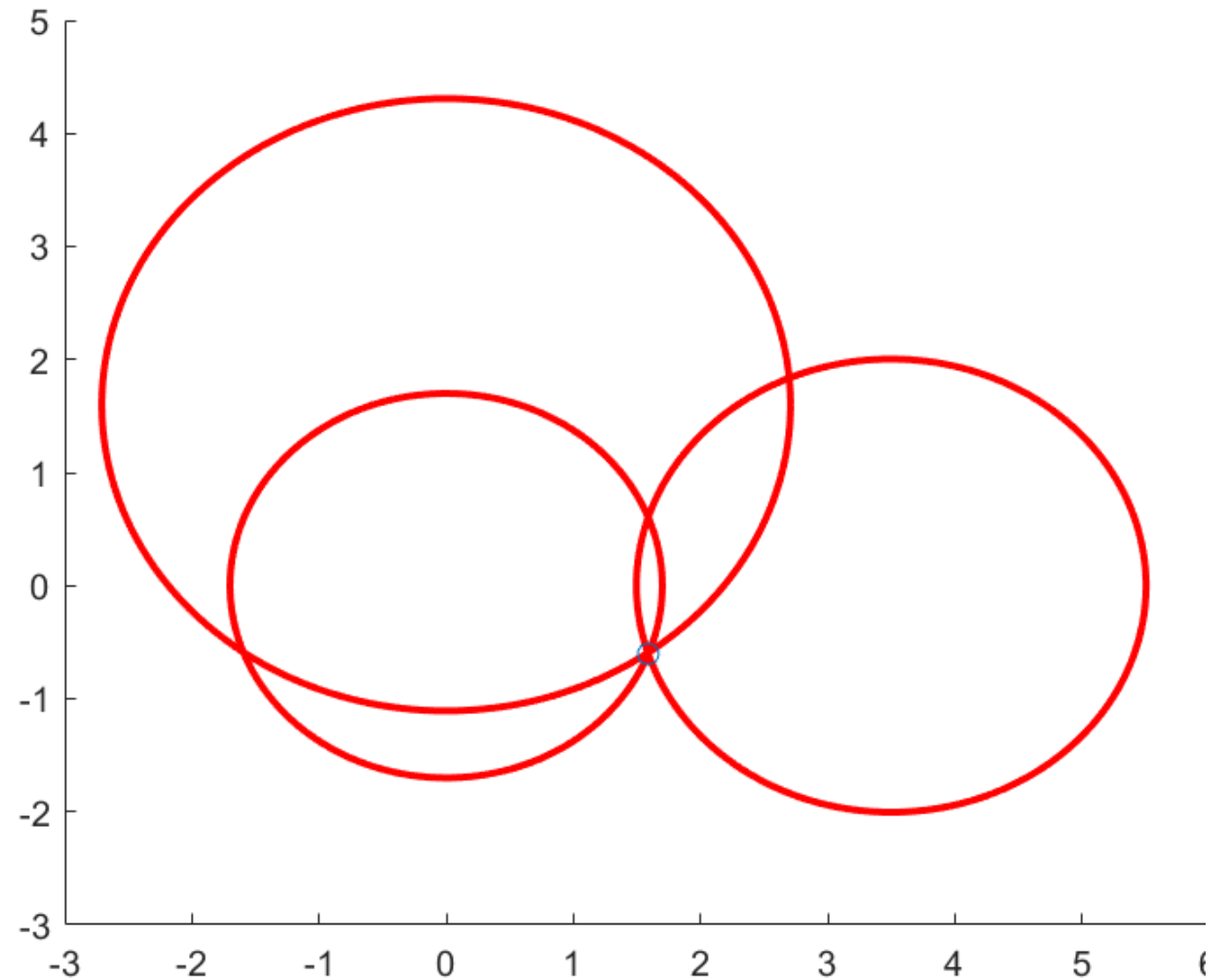






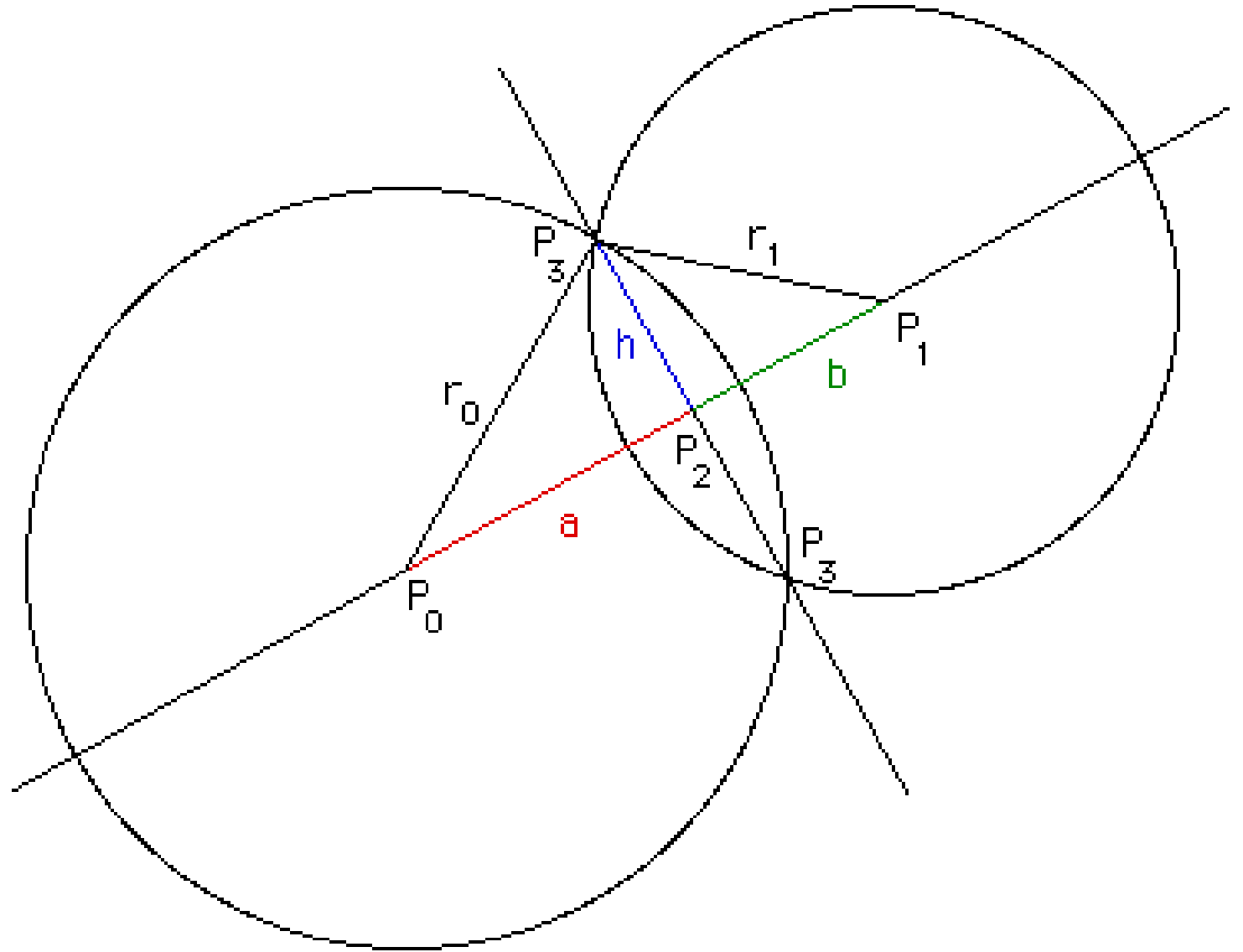
Modified trilateration

- Calculate the intersection of 2 circles
- Calculate which point from the previous step is close to the third circle



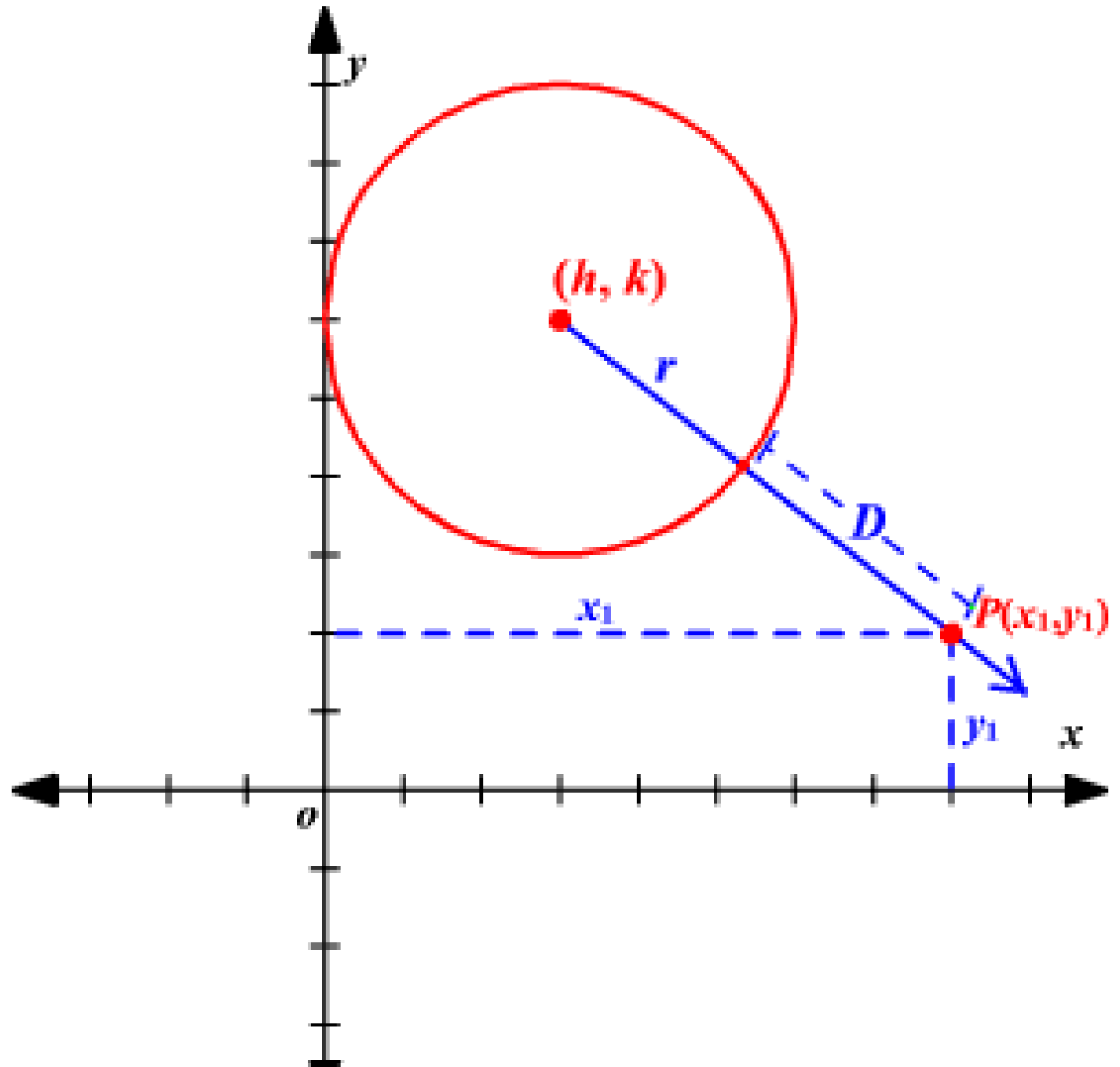
Intersection of 2 circles

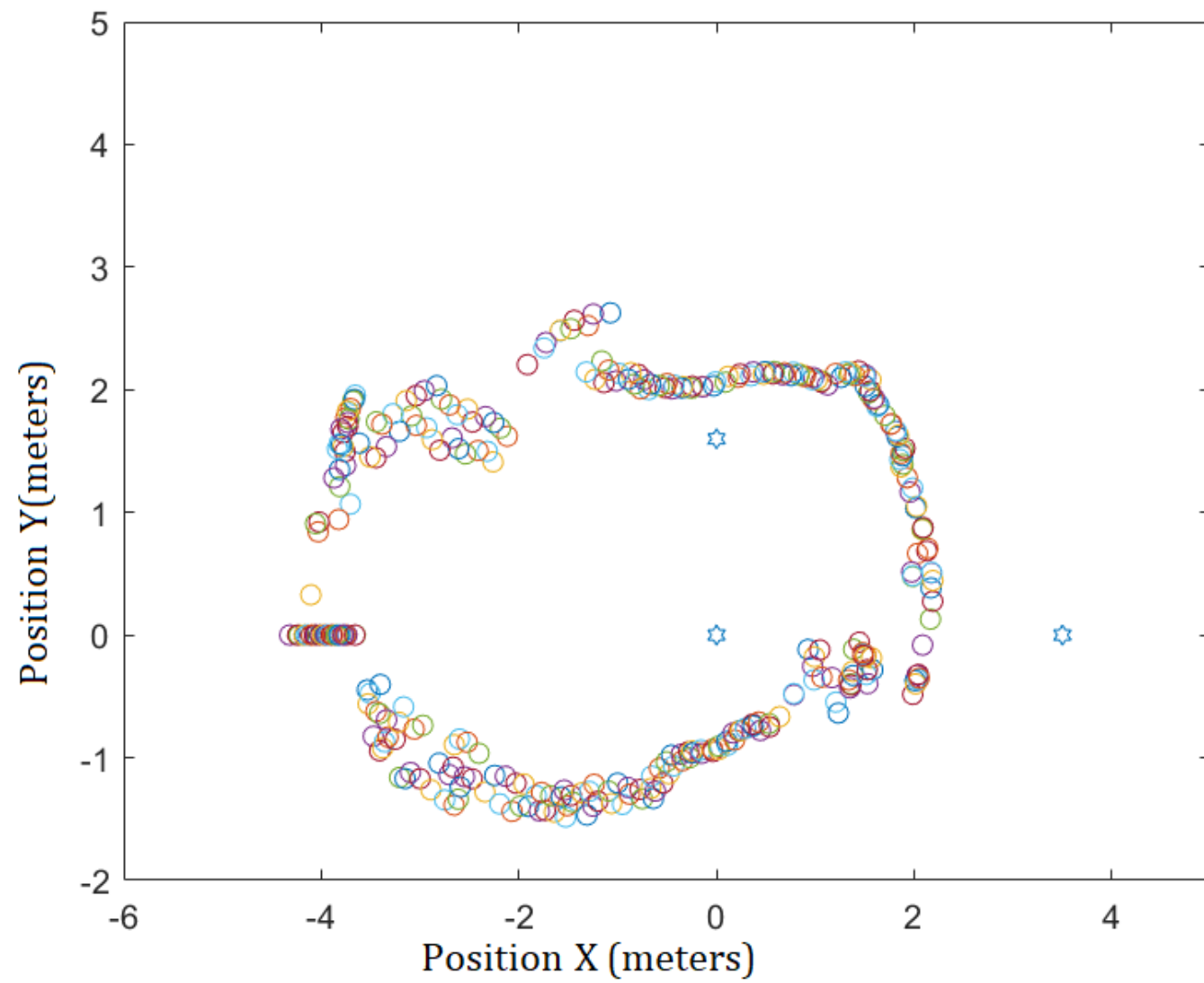
- $x_3 = x_2 \pm \frac{h(y_1 - y_0)}{d}$
- $y_3 = y_2 \mp \frac{h(x_1 - x_0)}{d}$
- $d = ||P_1 - P_0||$
- $a = \frac{r_0^2 - r_1^2 + d^2}{2d}$
- $h = \sqrt{r_0^2 - a^2}$
- $P_2 = P_0 + \frac{a(P_1 - P_0)}{d}$



Shortest distance from point to circle

- $d = |\sqrt{(x_1 - h)^2 + (y_1 - k)^2} - r|$







Thank you for
your attention

