

Mobile Radio Networks Tracing

Roberto Verdone
www.robertoverdone.org

roberto.verdone@unibo.it
+39 051 20 93817

Office Hours:
Monday 4 – 6 pm
(upon prior agreement via email)

A.Y. 2019-20
Credits: 6

Outline

- 1. Triangulation**
- 2. Inter-node contacts**

1. Triangulation

1. Triangulation

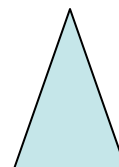
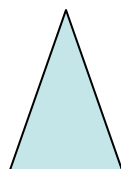
○ Anchor nodes



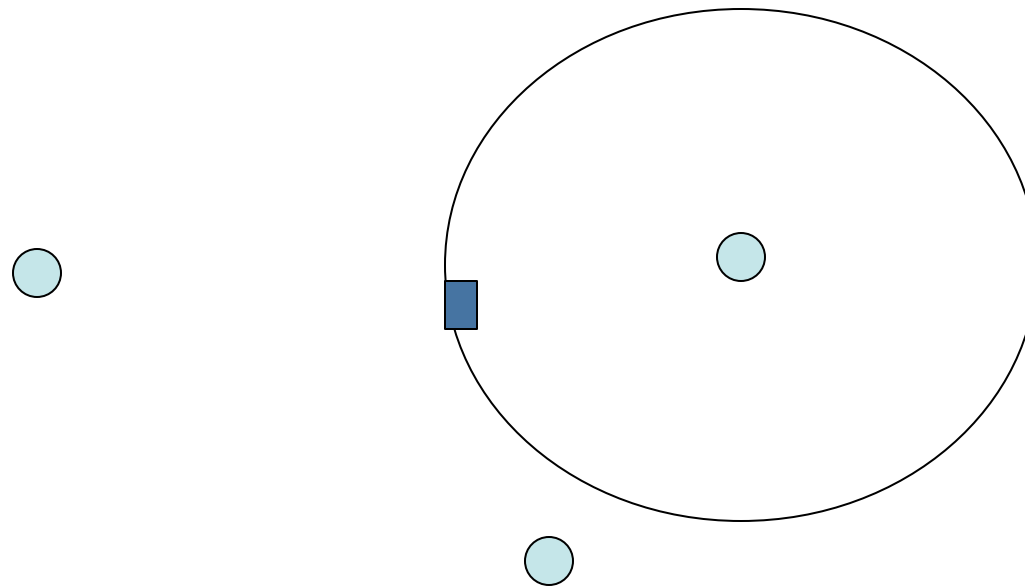
1. Triangulation



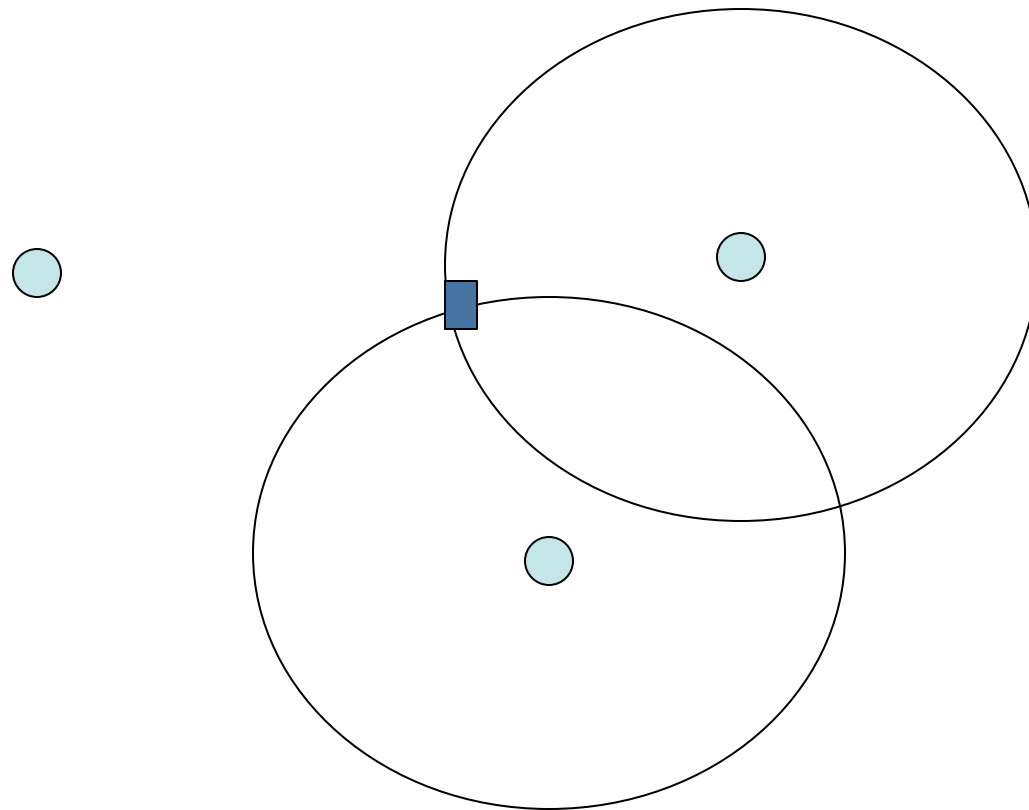
Base stations



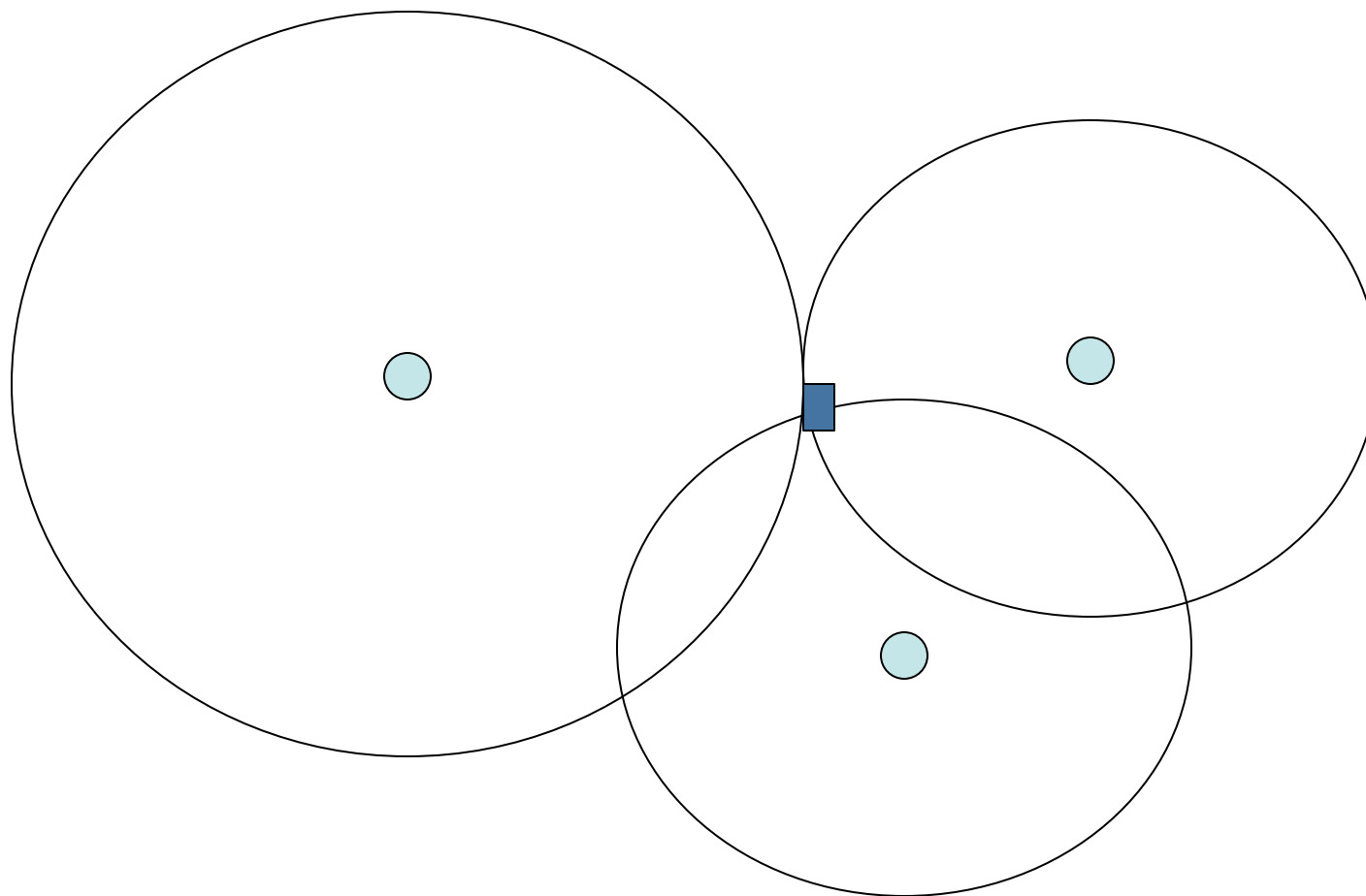
1. Triangulation



1. Triangulation

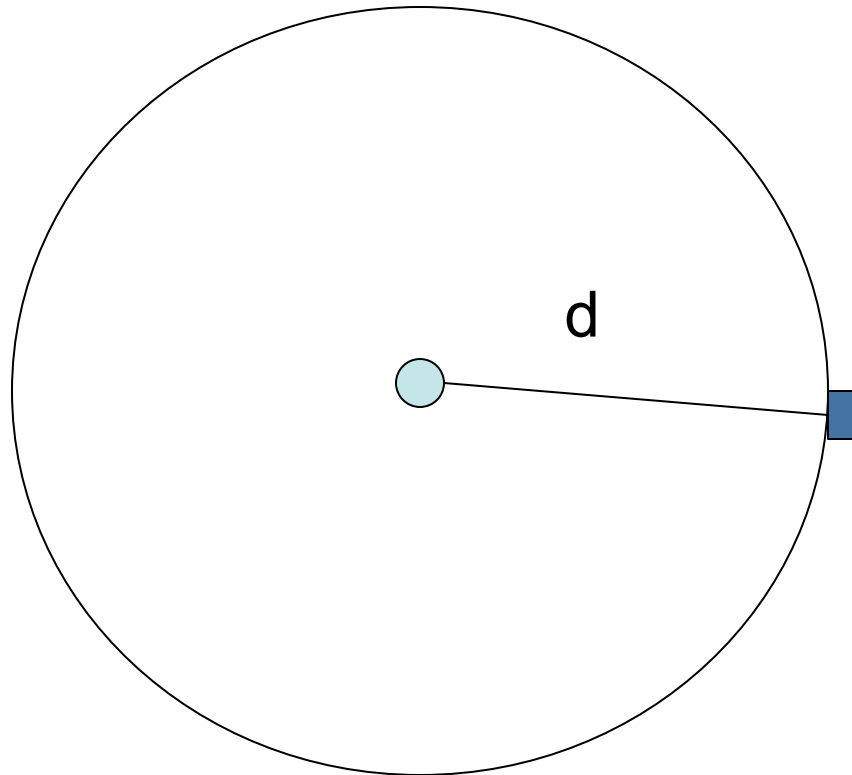


1. Triangulation



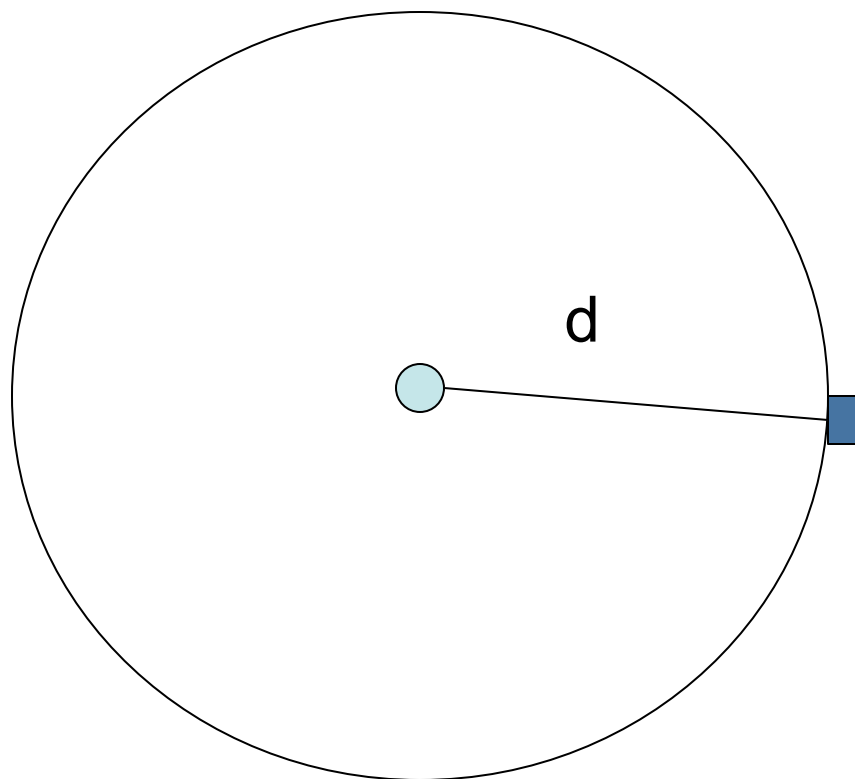
1. Triangulation

???



1. Triangulation

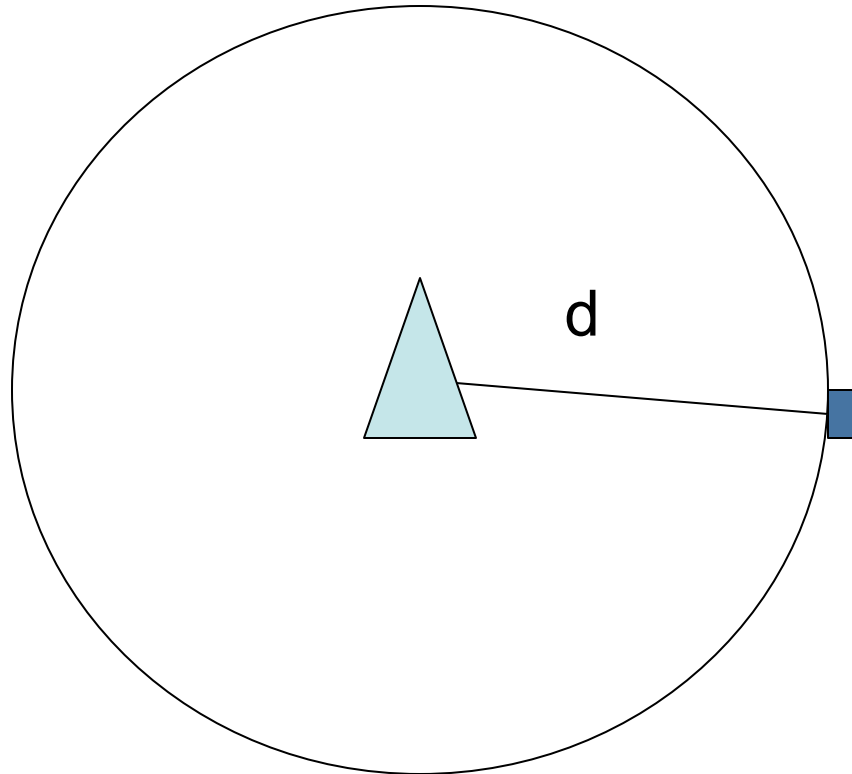
RSSI Based



$$P_r = k d^{-\beta}$$

1. Triangulation

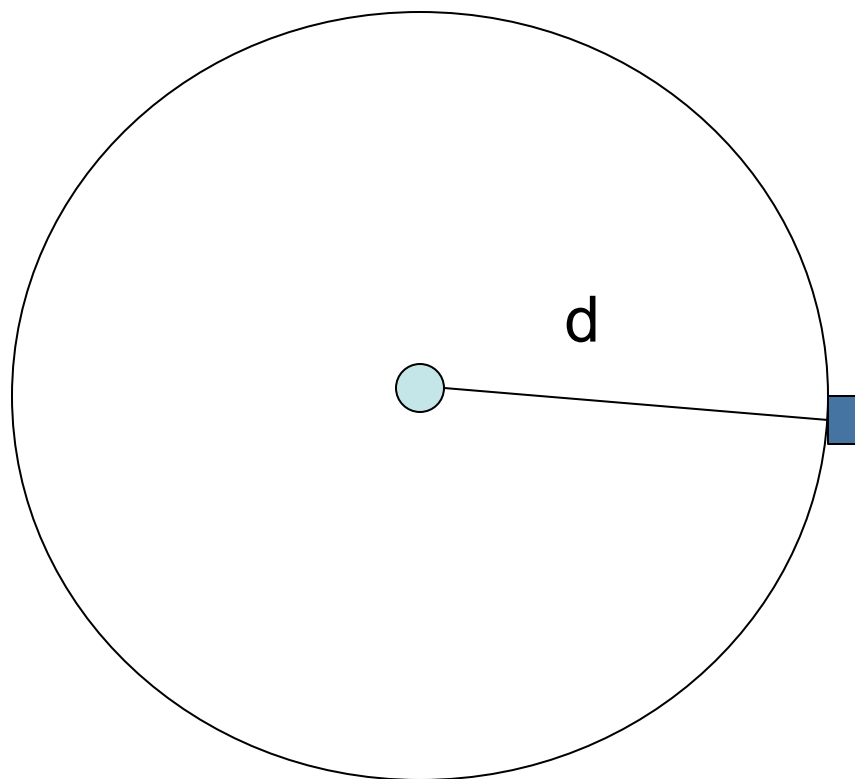
RSSI Based



Fading, shadowing ...

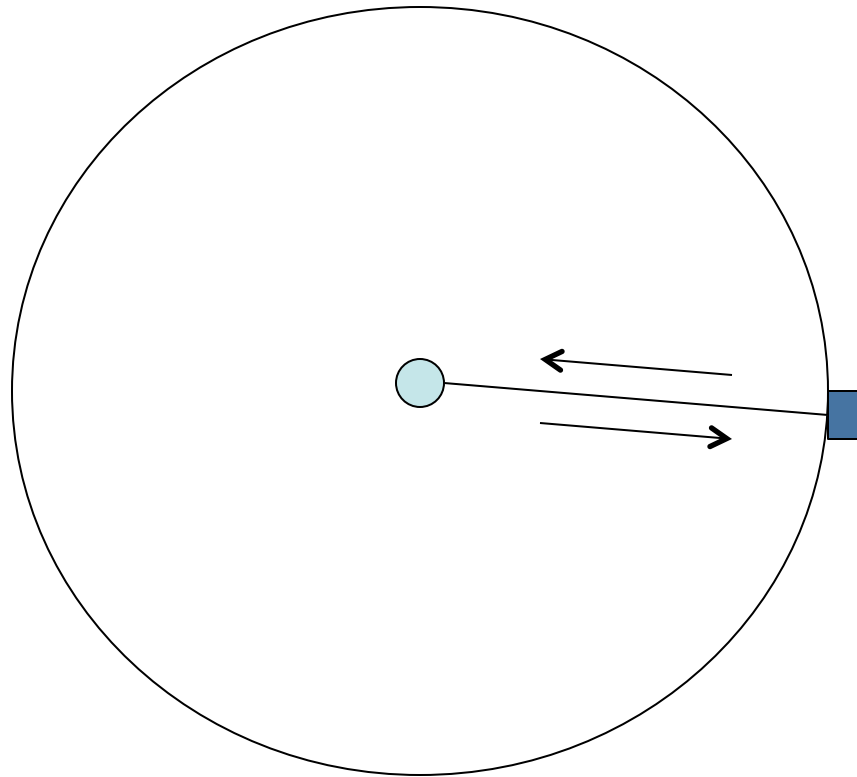
$$P_r = k d^{-\beta}$$

1. Triangulation



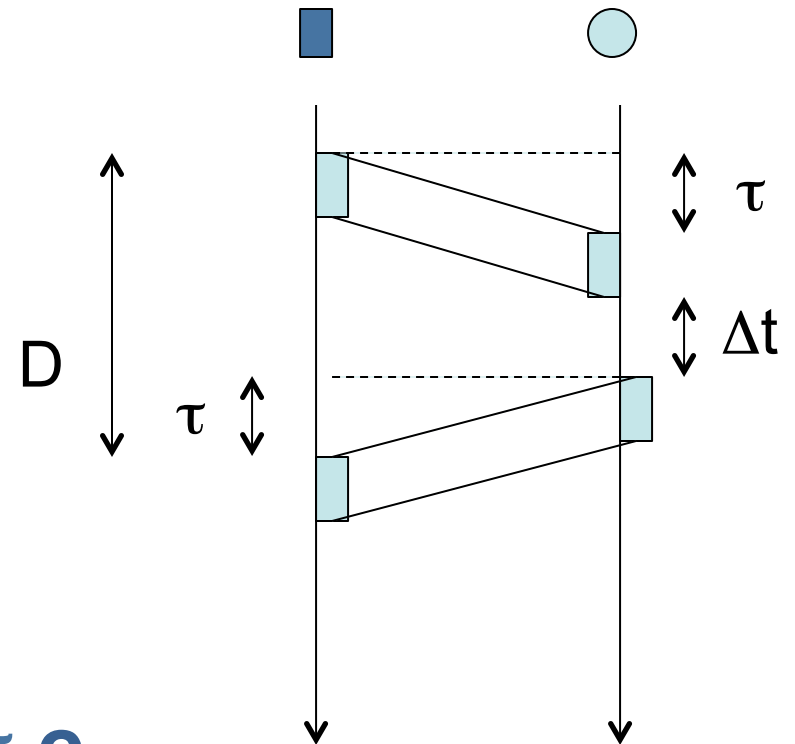
1. Two way
2. One way

1. Triangulation

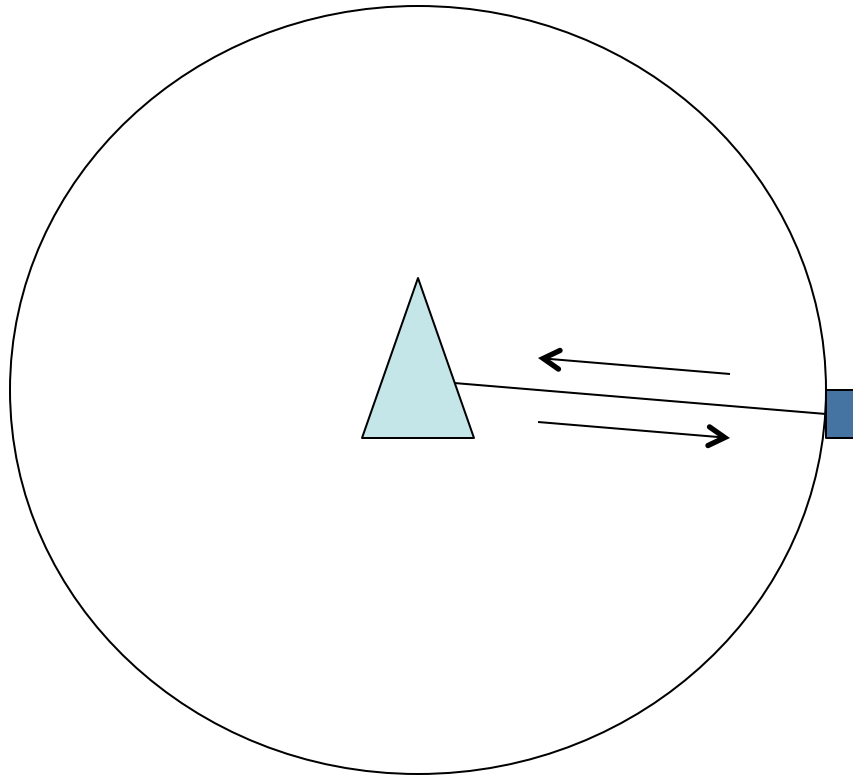


$$d = \tau c$$

1. Two way

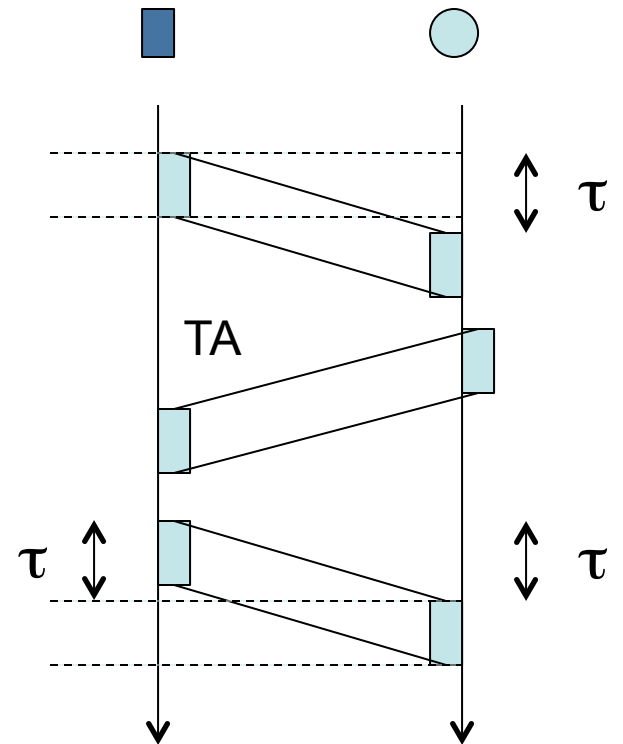


1. Triangulation

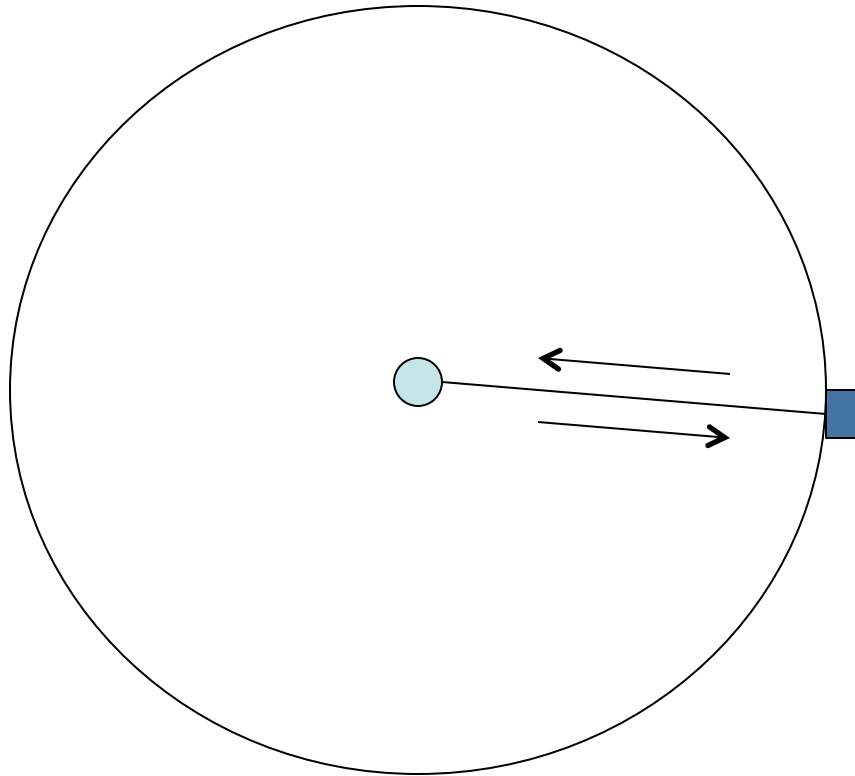


Connected mode

Timing Advance

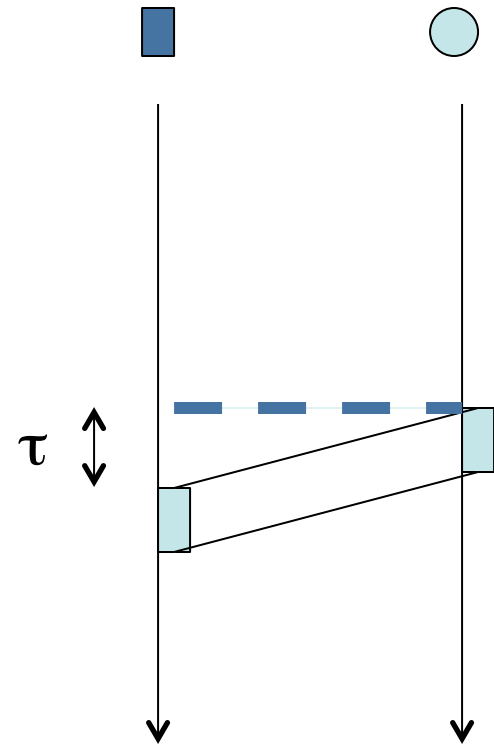


1. Triangulation

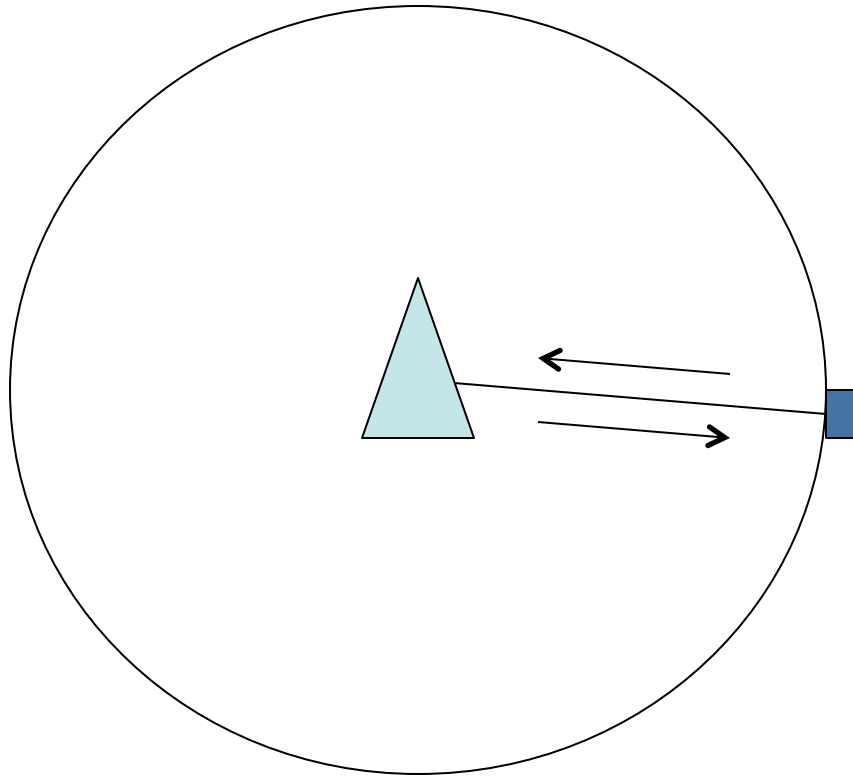


$$d = \tau c$$

2. One way

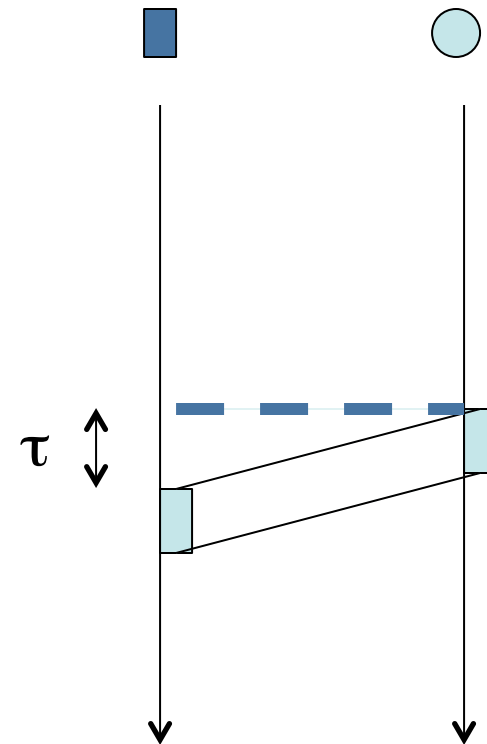


1. Triangulation

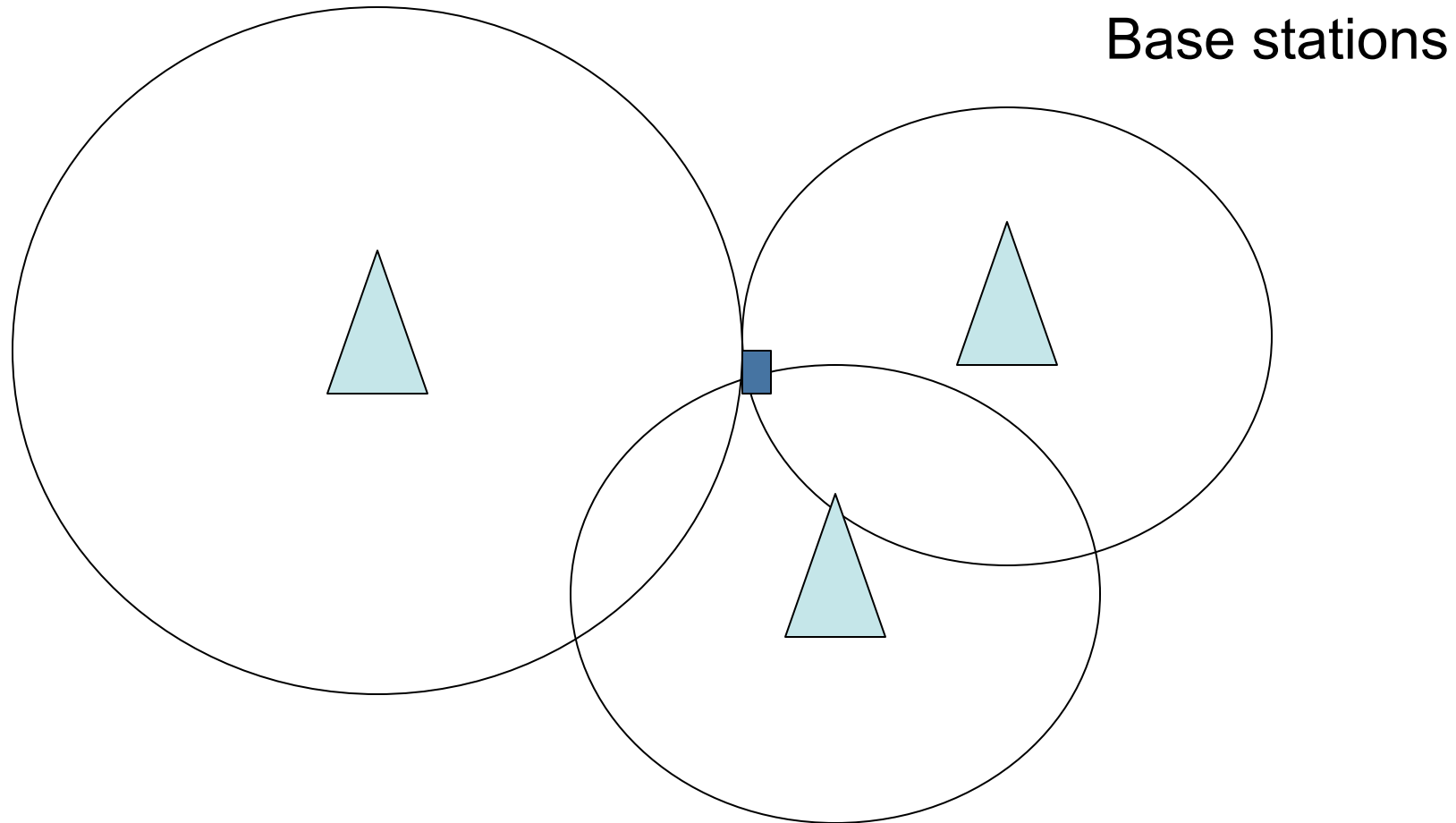


Network synchronisation

2. One way



1. Triangulation in 4G

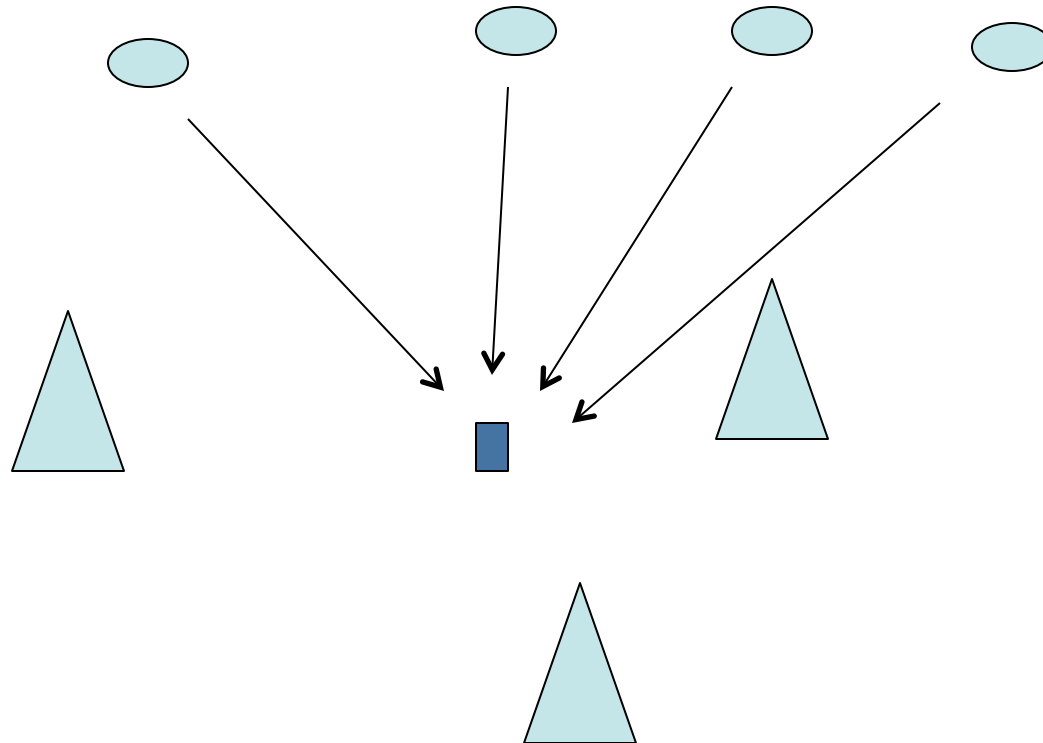


Idle and Connected Modes: RSSI

Accuracy = 150 m

1. Triangulation in 4G

Satellites

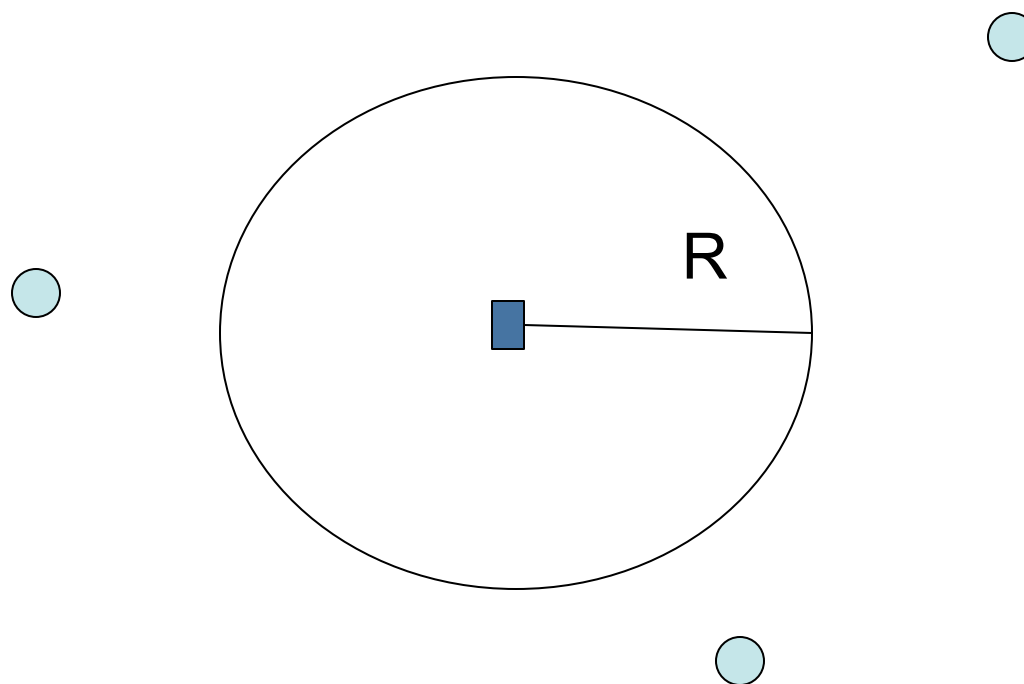


Connected Mode: MDT, based on GPS

Accuracy = 10 m

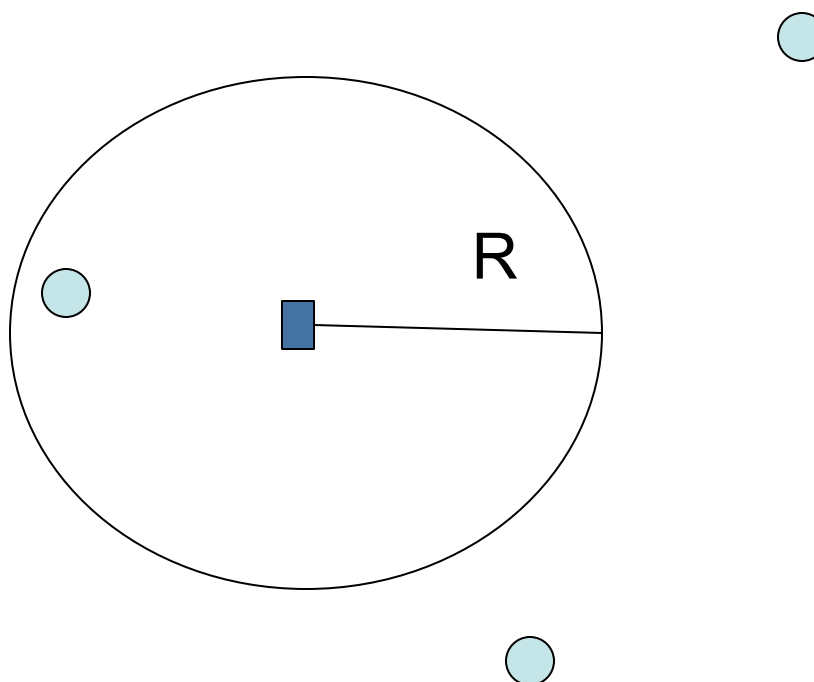
2. Inter-node contacts

2. Inter-node contacts



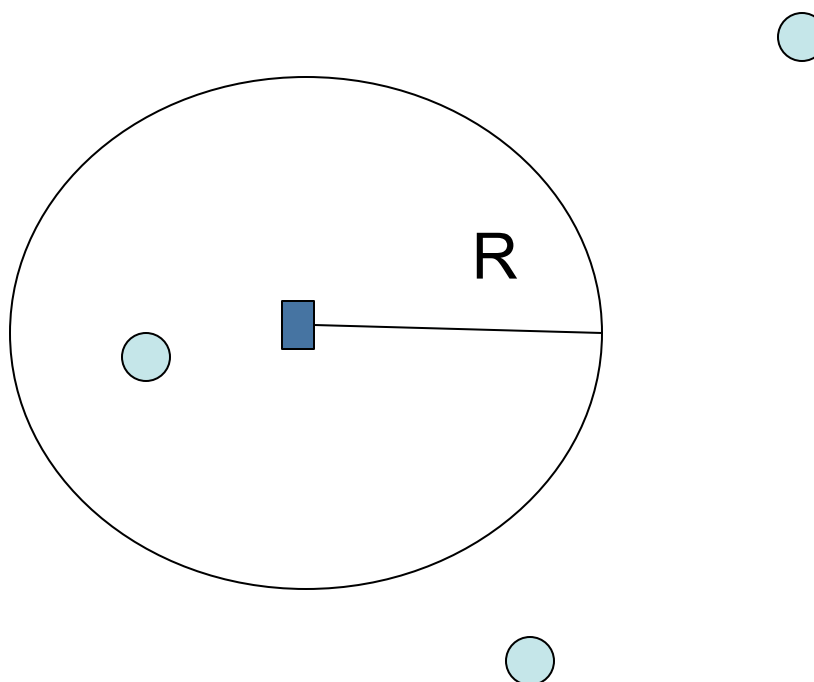
$$Pr = k d^{-2}$$

2. Inter-node contacts



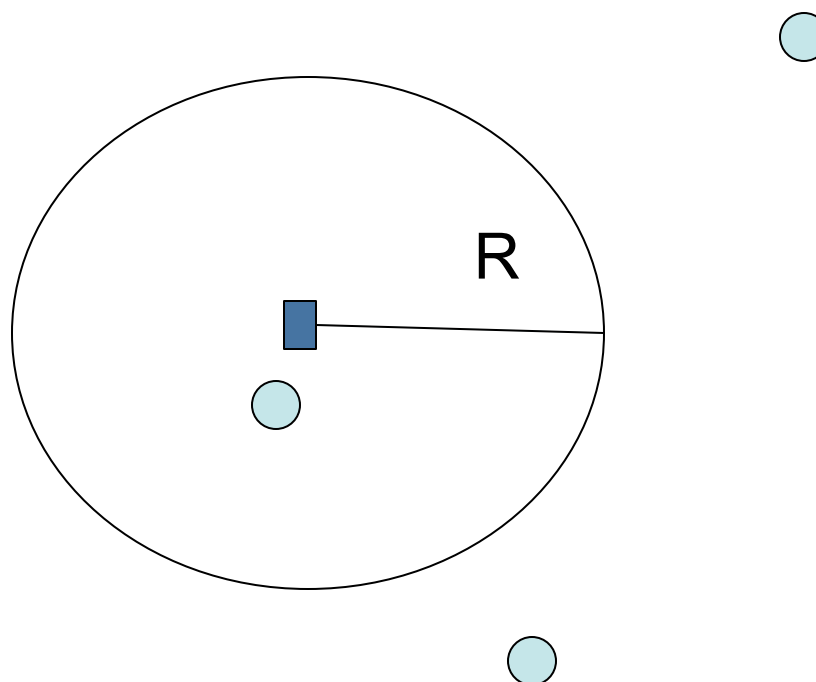
$$Pr = k d^{-2}$$

2. Inter-node contacts



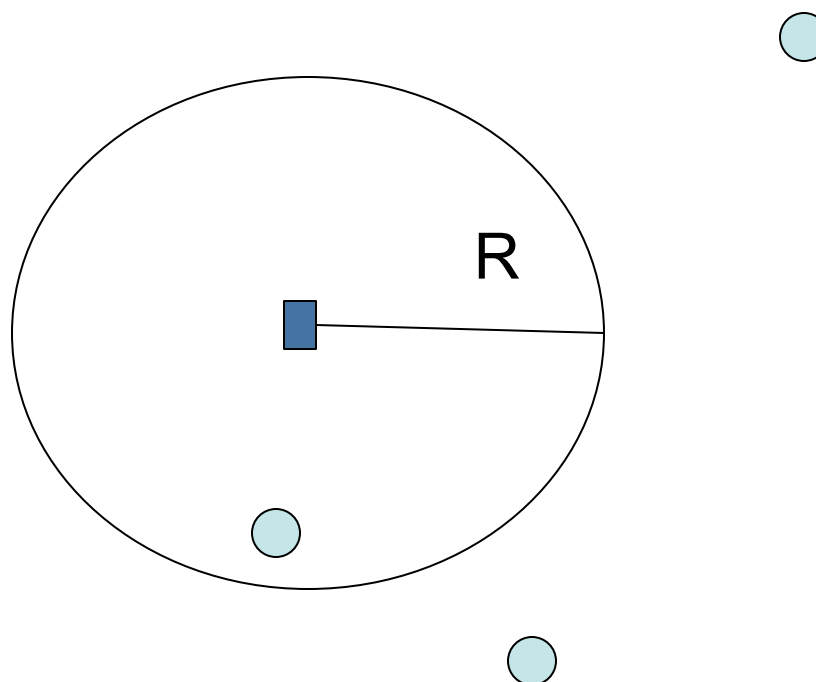
$$Pr = k d^{-2}$$

2. Inter-node contacts



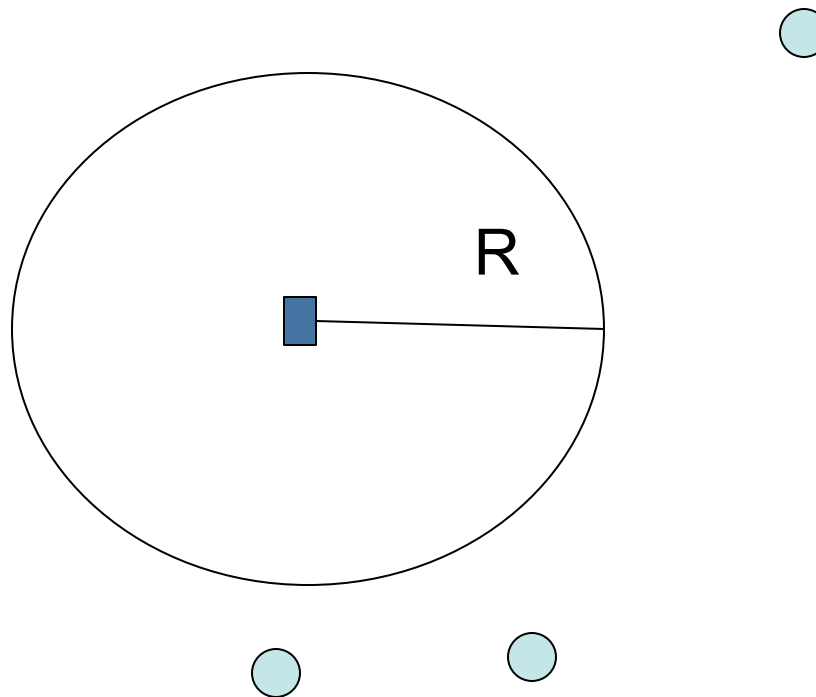
$$Pr = k d^{-2}$$

2. Inter-node contacts



$$Pr = k d^{-2}$$

2. Inter-node contacts and Immuni



Idle and Connected Mode: based on Bluetooth

Accuracy = 1 m