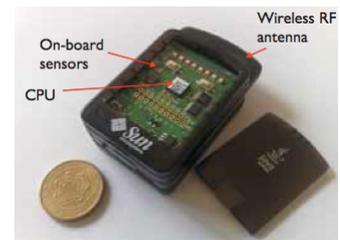


**In a nutshell:** A *decentralized system* is a special case of a *distributed system*. Decentralization is important in the increasing range of spatial information systems that present *geographic constraints to the movement of information*. Smartphones, vehicle ad-hoc networks, and *geosensor networks* are some examples of technologies that may require decentralization.

**Understand:** A *distributed system* requires multiple components to interoperate to complete some task. A *decentralized system* is a distributed system where no single component knows the entire system state. Decentralization becomes important to spatial information systems for several related causes:

- *Movement constraints:* Where information systems presents geographic constraints to the movement of information (i.e., where the further distance information is communicated, the more systems resources are consumed)
- *Information overload:* Where individual data items are near meaningless, and larger patterns are instead meaningful.
- *Scalability:* Where the number of components in the system may be very large and/or change substantially.
- *Latency:* Where information generated by the system is used by the system itself (*sensor/actuator networks*) and/or real-time knowledge is required.
- *Privacy:* Where privacy makes global knowledge of system state undesirable.

A *geosensor network* is a wireless network of sensor-enabled computing devices (called *motest* or *nodes*) monitoring changes in geographic environments. Geosensor networks typically exhibit many of the features above, so may benefit from decentralization. Similar features are often exhibited by technologies such as vehicle ad-hoc networks, smartphones.



As a simple example of a decentralized spatial computing, imagine computing whether a crowd (of, say, 1,000 people) exists at a soccer match. We could take a photo and count heads (centralized). Or we could ask someone an individual to place a tally mark on a piece of paper, pass it to a randomly selected neighbor subject to three rules: 1. please add a tally to the paper only if you have not already done so; 2. check the tally to see if it contains 1,000 tally marks; 3. if it does, shout out “Crowd!”; if not, just pass the paper to another randomly selected neighbor.

Decentralized spatial computing is concerned with computing with information *about* geographic space at the same time as computing *in* geographic space. Today, we have amassed a huge library of tools and techniques for computing with spatial information that assume a logically centralized data source. There exist today only a handful of algorithms and data structures that relax that assumption.

#### **Discuss:**

- What other technologies, aside from geosensor networks, smartphones, VANETs, might require decentralization, now or in the future?
- Think of some examples of spatial information systems or applications that do *not* require decentralization. Why is that?
- What could go wrong with the decentralized “Crowd!” computing algorithm?
- Think about your favorite GIS/spatial database algorithm or data structure. How might you begin to decentralize it?

**See:** Chapter 1 in Duckham (2012) *Decentralized Spatial Computing*, Springer, Berlin.