Connectivity of Wireless Sensor Networks
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Wireless Sensor Networks
- Sensor nodes are randomly distributed.
- Usually no centralized control.
- Limited battery life
- Connectivity issues: How many neighbouring nodes can one node have? What is the node density that gives us a connected network?

Wireless Environment
- Attenuation: signal power decays with transmission distance.
- Therefore, a node can only be connected to neighbours within certain distance.
- The obstacles and scatters in the wireless environment causes variations in the received signal strength at different locations.
- The change in the wireless environment also causes the received signal strength to change with time.

Connectivity Measures
- Small-scale connectivity, such as the connection range and the coverage area of a node.
- Large-scale connectivity, such as the probability that two randomly chosen nodes in the network are connected directly or indirectly.

Impact of Wireless Environment on the Connectivity of Wireless Sensor Networks
- First of all: signal attenuation is always bad for connectivity.
- Now: what about the signal variation (in space and time) caused by the wireless environment?
  1. on the small-scale connectivity: Coverage area
  2. on the large-scale connectivity: Probability of two randomly selected node being connected.
- Summary: The signal variation caused by the wireless environment is bad for small-scale connectivity but good for large-scale connectivity.
- Practical implication: By accurately characterizing the wireless environment, we can deploy a minimum number of nodes to meet a target connectivity level.

The Use of Antenna Arrays
- Antenna array: multiple antennas are used at each node.
- What can antenna arrays do: concentrate the transmit power into certain direction, i.e., beamforming
- Impact on connectivity: even with random beamforming, the use of antenna arrays can increases both small-scale and large-scale connectivity in certain wireless environment.

Relayed and Cooperative Transmissions
- Relayed transmission:
  1. The use of multi-hop reduces the transmit power required for connecting the source and the destination.
  2. The use of multi-path utilizes the signal variations caused by the wireless environment, and hence improves the connectivity.
- Clustered transmission:
  1. Nodes that are close to each other form a cluster.
  2. Nodes in a cluster cooperate by sharing their transmit power to improve the connectivity between clusters.

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