Spectrum Allocation for Wireless Networks in Agricultural Environments

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Wireless sensor and actuator networks will become a key component of future agricultural systems. They have been proposed for a variety of applications including pest control, precision irrigation, fertilizer delivery, frost detection, fire detection, detection of crop maturation, silage monitoring and livestock tracking.

The environments within which agricultural wireless networks are deployed are extremely diverse and much different from those encountered in commercial or residential environments. By their nature, they present high vegetation densities and cause wireless signals to incur high path loss, particularly as carrier frequency increases. They may be composed of low bushes and shrubs, root vegetables planted in raised soil ridges, regular rows of stalks, uniform fields of wheat and other grains, dense orchards, and forested plantations of tall thick trunks with dense, leafy canopies. In many cases the vegetation density can change considerably throughout the growing season. Within such environments, wireless signals are absorbed, reflected, and diffracted by any stalks, trunks, leaves, and branches that obstruct the propagation path. Terrain can also vary considerably, from flat to complex topography depending on the crop type and region, and networks that are deployed in hilly environments must be able to overcome severe shadowing effects. As a result, the system link power budget is dependent on crop morphology and terrain in addition to more common factors such as carrier frequency, node spacing and antenna height.

When selecting appropriate frequency bands for the low throughput networks that will be used in the majority of agricultural applications, coverage and power consumption are the primary concerns. This is fundamentally different than for the case of personal communication services, in which bandwidth and data rate are the key issues. For manufacturers of wireless networking equipment intended for use in agricultural applications, the lack of worldwide spectrum allocations that reflect the unique nature of the agricultural environment is presenting a significant impediment to market growth. Here, we consider the disadvantages of deploying low power agricultural wireless networks in traditional license-exempt bands and how their unique nature and the environment in which they are deployed affect the selection of appropriate license-exempt spectrum.