The Challenges of using Wireless Mesh Networks for Earthquake Early Warning Systems

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***Abstract*—The total cost of an Earthquake Early Warning System (EEWS) can be substantially decreased by using Wireless Mesh Networks (WMNs), which are inexpensive computer networks whose nodes communicate wirelessly using a license-free spectrum in a self-organized manner. The Early Warning System triggers on the small-amplitude, but fast P-wave in order to shutdown critical infrastructures before the destructive, but slow S-waves arrive only a few seconds later. It demands low-latency communications of high robustness. We conducted shakeboard-based measurements using IEEE 802.11a/b. Innovatively, our tests show that already for the slight shaking related to P-waves representative for strong ($M_w > 6$) and nearby (epicentral distance $<$ 40 km) earthquakes, the performance of the wireless communications can be considerably affected at the very moment when the Early Warning system is supposed to be used. We observed swift link quality oscillations of up to 10 dB within only half a second. The more an environment is vulnerable to multi-path interference and shadow fading, e.g. no line of sight (NLOS), the more erratic are the wireless links between nodes. However, for clear line of sight (LOS) the influence of the vibrations is negligible. We recommend several measures that should be applied in order to make the unique use case of Earthquake Early Warning, nonetheless, well-functioning on top of a Wireless Mesh Network. A higher fade margin, in our setup at least an additional 5 dB, should be included to cope with sudden link fading. Moreover, antenna diversity should be enabled as it strongly mitigates the adverse effects of shaking.**

***Index Terms*—Wireless Mesh Networks, Earthquake Early Warning Systems, Measurements**