

Smart Grid Standards for Operation in Sub-1 GHz Bands

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Smart Grid Standards for Operation in Sub-1 GHz Bands

Intended audience

This white paper is intended to provide information on the benefits and applications of IEEE 802® wireless standards operating in sub-1 GHz bands.¹ The intended audience is regulators, communication network planners for utilities, and users and developers of a variety of wireless Internet of Things (IoT) networks.

Why is sub-1 GHz of interest for Smart Grid?

In many of the deployment environments and scenarios for smart grid devices, the frequencies below 1 GHz provide superior propagation characteristics compared to higher frequencies. For example, using simple modulation, signals at 900 MHz will tend to penetrate foliage (e.g., trees, shrubs, other plants) more readily compared with 2.4 GHz, which is attenuated more by the water contained in plants and animals. Propagation through some building materials may also be improved at lower frequencies. The effective antenna aperture will be improved at lower frequencies as well (to a point). Bands in the 400 MHz to 900 MHz frequency range provide good tradeoffs.

In most regions of the world, there are license-exempt frequency allocations between 800 MHz and 1 GHz, and in many regions there are allocations in the 400 MHz to 500 MHz frequency ranges as well. IEEE 802 standards include operating modes to address these sometimes-limited allocations effectively, with simple and low-cost implementations.

At the end of the paper, calculations are presented to compare the link loss difference between a sub-1 GHz band at 902–928 MHz with the 2.4 GHz band, keeping all other variables equal. The parameters are typical of a commonly-available, moderately low data rate radio as is popular in many smart grid and IoT related applications such as metering and remote monitoring. It should be noted that other factors beyond propagation loss, including required data rate, would drive selection of a band. For example, the contiguous spectrum available at 2.4 GHz is much larger than what is available in sub-1 GHz bands in many regions; therefore, the maximum data rate achievable may limit the use of lower frequencies for applications that require high data volumes.

The example calculations are based on the NIST link budget calculator.² The “Small City” model was used since this approximates an urban environment. The results show, with all other factors equal, the link in the 915 MHz band provides a link reliability of 90% at 1.1 km. The same link at 2.4 GHz provides a link reliability of 90% at 0.589 km.

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²NIST link budget calculator is at rfic.eecs.berkeley.edu/~niknejad/ee242/pdf-lock/NIST_LinkBudgetCalc_2_4_konglk.xls

Industrial, scientific, and medical (ISM) bands have many incumbents and existing users in the bands. The nature of these users depends on the regulatory domain. In North America, the 915 MHz band is less congested than the 2.4 GHz band, but it is still used by multiple services and devices. One notable user is the Progeny location service that operates in the 915 MHz ISM band under a license, and thus can transmit with much higher power levels.

In the TV White Space (TVWS) spectrum, the incumbents are TV broadcasters. TVWS operation is only permitted in areas and on channels that are unused. The status of unused is based on conservative rules intended to eliminate any possibility of interference with broadcasters. In many large metropolitan areas, there are no available channels. In rural areas, there are many. After the FCC auctions much of the 600 MHz band, there will be even less availability of TVWS channels.

Standards for regional sub-GHz channel plans

Figure 1 summarizes IEEE 802 wireless standards with channel plans specifying operation below 1 GHz.

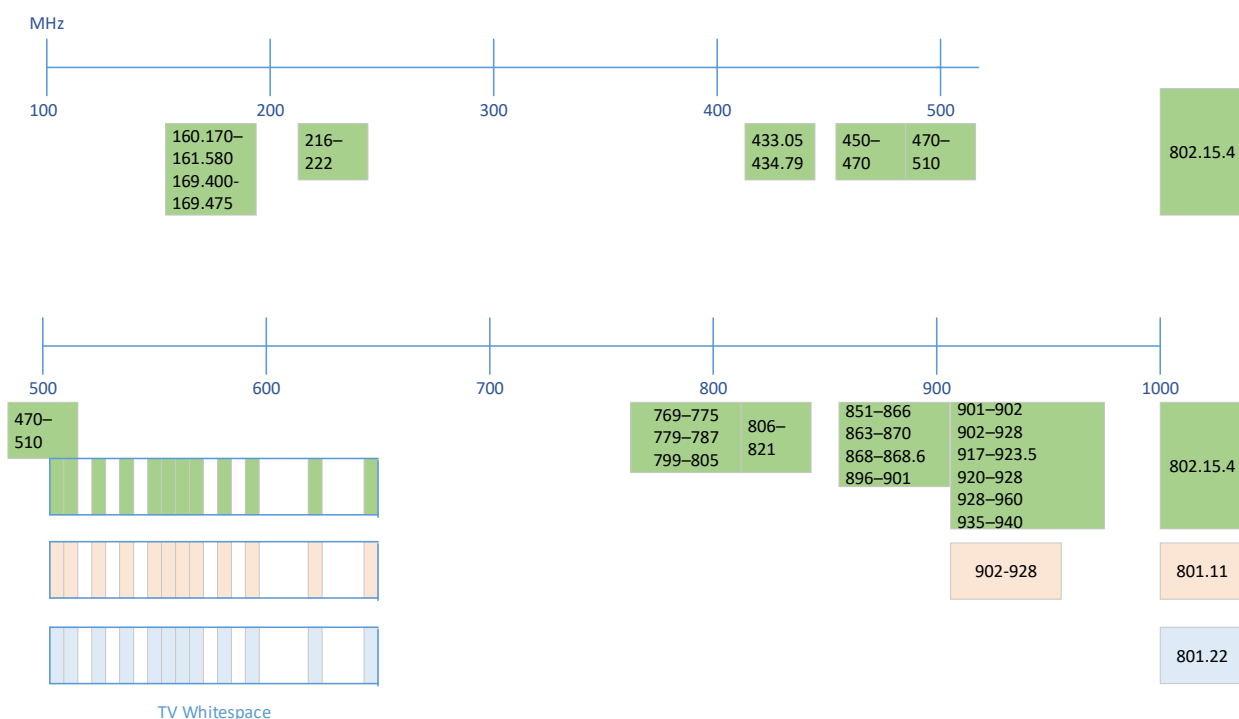


Figure 1 —Channel plans below 1 GHz