

In the name of God



An overview of the IEEE 802.22 Standard

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Summary

- This tutorial gives a detailed overview of the IEEE 802.22 standard based on Cognitive Radios (CR) for the Wireless Regional Area Networks (WRAN).
- It's an air interface which is defined for allowing to unlicensed users to work in TV bands when the incumbents (primary users) are not present in the network.
- To achieve enough flexibility and adaptability the CR techniques are used in this standard



Outline

- Background
- The frequency usage in TV bands
- Some advantages of the IEEE 802.22
- The technology of the IEEE 802.22
- The enhanced IEEE 802.22 standard
- Conclusion



Background

- This standard was proposed in November/2004, by the IEEE 802.22 Working Group (WG) and published in a 2005 IEEE paper and was accepted and used by FCC (Federal Communication Commission).



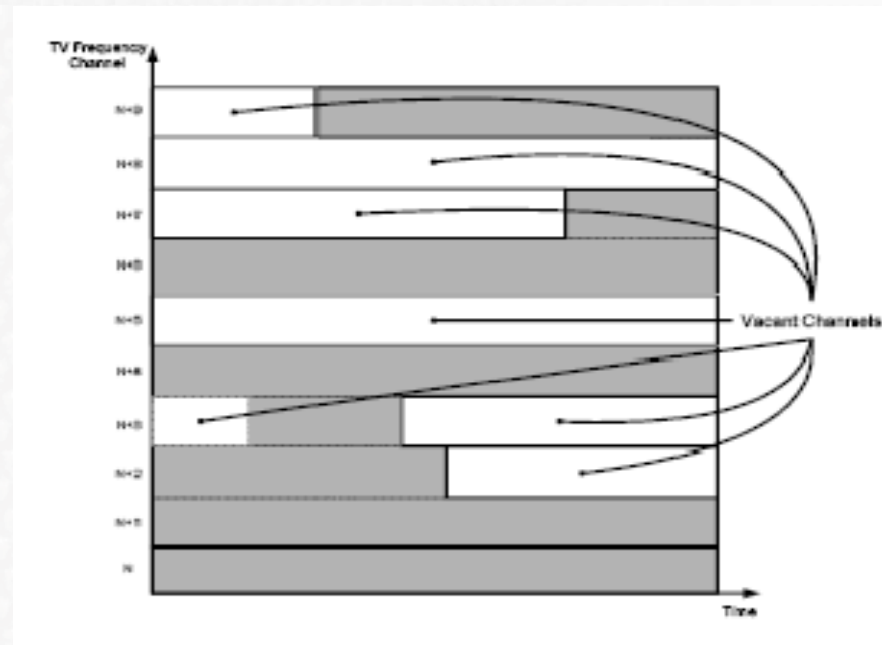
The frequency usage in TV bands

- In TV bands , in addition to the TV services, other services such as wireless microphones are also allowed by FCC to operate on vacant TV channels on a non-interfering , and so are Private Land and Commercial Mobile Radio Services (PLMRS/CMRS). These are incumbents in TV bands
- But these primary users are not present in all times and places...

Look at the next picture...!



The frequency usage in TV bands (CONT.)



Example of TV band occupancy over time and frequency



Some advantages

- Some of previous standards may use the higher frequency bands which are more available. For example 802.11 uses the 5GHz, or 802.15.3.c uses the 57-64 GHz. But the use of high frequencies has some disadvantages in cost and design. But the IEEE 802.22 users are secondary users in the TV bands which are in lower frequencies.
- The IEEE 802.22 standard can provide various type of services like data, voice, audio & video with appropriate Quality-Of-Service (QoS) support.



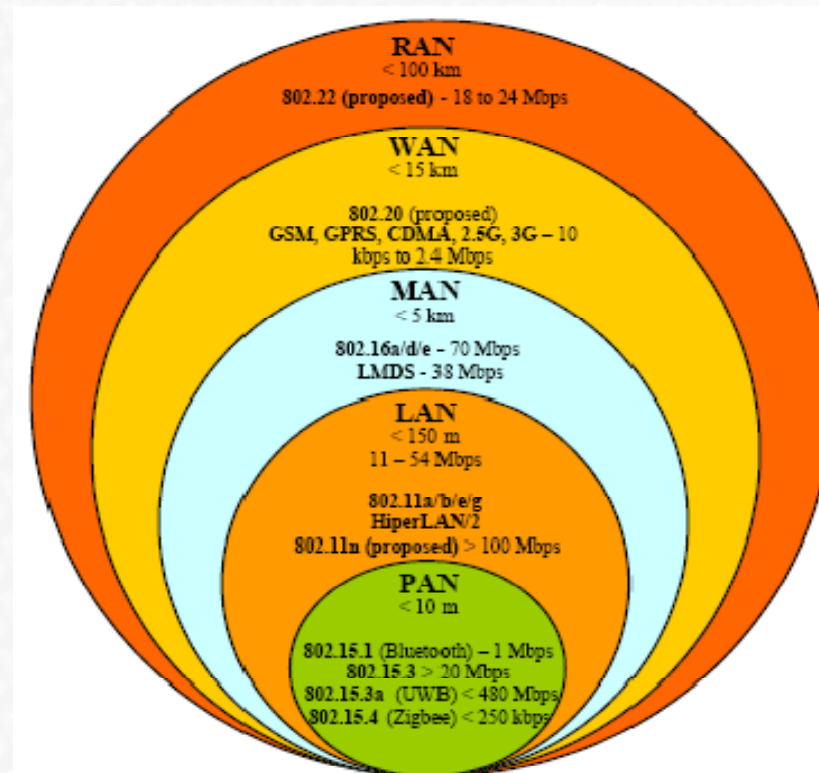
Some advantages (CONT.)

- The 802.22 system specifies spectral efficiencies in the range of 0.5 bit/(sec/Hz) up to 5 bit/(sec/Hz).
- The terminology, Wireless *Regional* Area Network (WRAN) for 802.22 implies that the coverage area is much larger than that of other IEEE 802 standards e.g. personal, local and metropolitan area networks: PAN, LAN, & MAN respectively.

Look at the next picture...!



Some advantages (CONT.)



802.22 wireless RAN classification as compared to other popular wireless standards



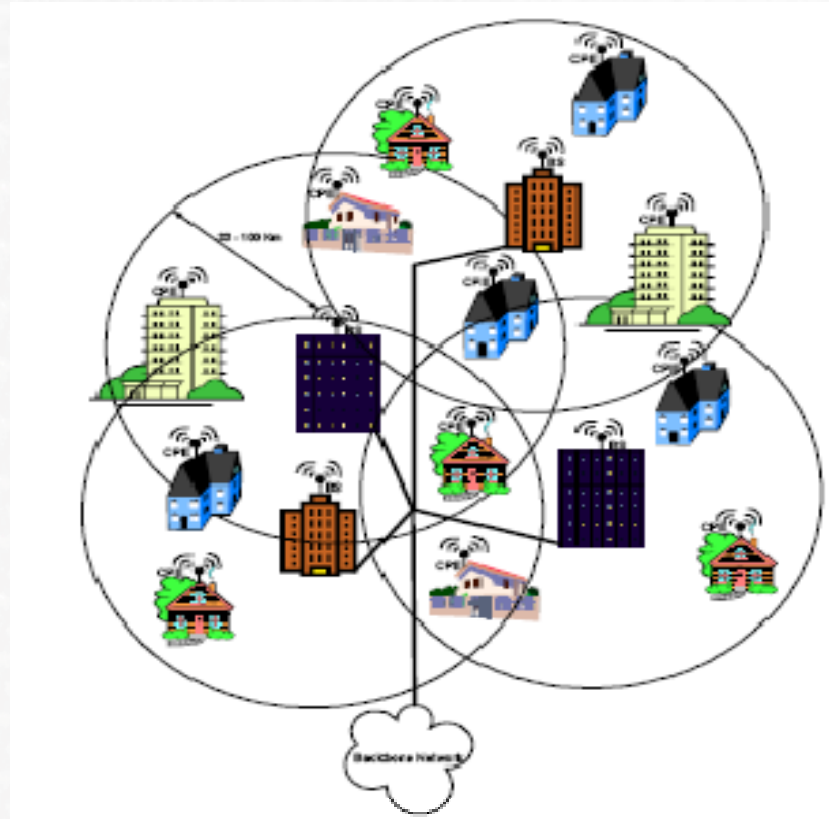
The technology of the IEEE 802.22

- An IEEE 802.22 cell is formed by a single Base Station (BS) and zero or more Consumer Premise Equipments (CPEs) which are under the control of the BS.

Look at the next picture...!



The technology of the IEEE 802.22 (CONT.)



Exemplary 802.22 deployment configuration



The technology of the IEEE 802.22 (CONT.)

- The operations of BS/CPEs can be divided into two major categories in IEEE 802.22: sensing and transmitting/receiving data.
- The relations between these components is a master/slave relation. It means that the control of the whole cell is done by the BS (master) and no CPEs (slaves) can transmit before receiving authorization from the BS.
- The IEEE 802.22 standard is defined in PHY and MAC layers of the network.



The technology of the IEEE 802.22 (CONT.)

- Whenever a CPE is switched on , it should scan all the TV channels to determine the vacant frequencies.
- Then the CPE should find a proper channel to look for and aware the BS of its presence in the network. This step is not also very straightforward, because in this standard there isn't a pre-determined channel a CPE can look for a BS.
- When the BS becomes aware of the existence of the CPE, by periodic spectrum sensing and also based on the feedback about the vacant frequencies received from the CPEs, selects the appropriate channel to communicate with the CPE. Then the BS allows the CPE to start communication



The technology of the IEEE 802.22 (CONT.)

- This process i.e. periodic spectrum sensing by the BS and receiving the feedback from the CPEs continues during the communication in order to change the channel appropriately in any time, so that the spectrum utilization becomes maximized and interference to the incumbents and also existing CPEs becomes minimized.
- Note that the message that the BS broadcasts to the CPEs in a cell is differentiated from other TV broadcasts by the preamble signal sent at the start of each frame, so that is determinable by the CPEs.



The enhanced IEEE 802.22 standard

- In the enhanced version of the IEEE 802.22 standard two major problems have been solved :

The hidden incumbent problem



The self-coexistence problem



The enhanced IEEE 802.22 standard (CONT.)

- We can say hidden incumbents are the primary users which can be sensed by the CPE but not by the BS. It means that hidden incumbents are in the sensing region of the CPE but not the BS's.
- The self-coexistence isn't sometimes well considered in the IEEE 802.22. In areas with high analog/digital TV transmissions and wireless microphones (i.e., the incumbents) there is a chance that the secondary operators will try to act greedy and occupy the available bandwidth. This may result in interference among IEEE 802.22 networks themselves. This problem has solved in the enhanced version of this standard by a method called *graph coloring model*.



Conclusion

- In this research, we provide a detailed overview of the IEEE 802.22 standard, a based CR standard for WRANs, which is defined as unlicensed users in TV bands. We explained the technology of this standard and introduced an enhanced version of this standard to solve some of its problems.



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Thanks a lot...!

Any QUESTIONS...

