INTRODUCTION

* The radio spectrum needed for applications such as mobile telephony, digital video broadcasting (DVB), wireless local area networks (WLAN), wireless sensor networks , and Internet of things, is enormous and continues to grow .

* With the demands of wireless technologies and applications, more and more spectrum resources are needed. This spectrum is a limited resource and is usually allocated through a licensing process by regulatory bodies.
* The spectrum bands are exclusively allocated for licensed users (primary users PUs), and unlicensed users (secondary users SUs).

* The spectrum in certain frequency bands like that of GSM and Wi-Fi are crowded and congested while frequency bands like that of the military are hardly used at all.
* This results in spectral inefficiency.

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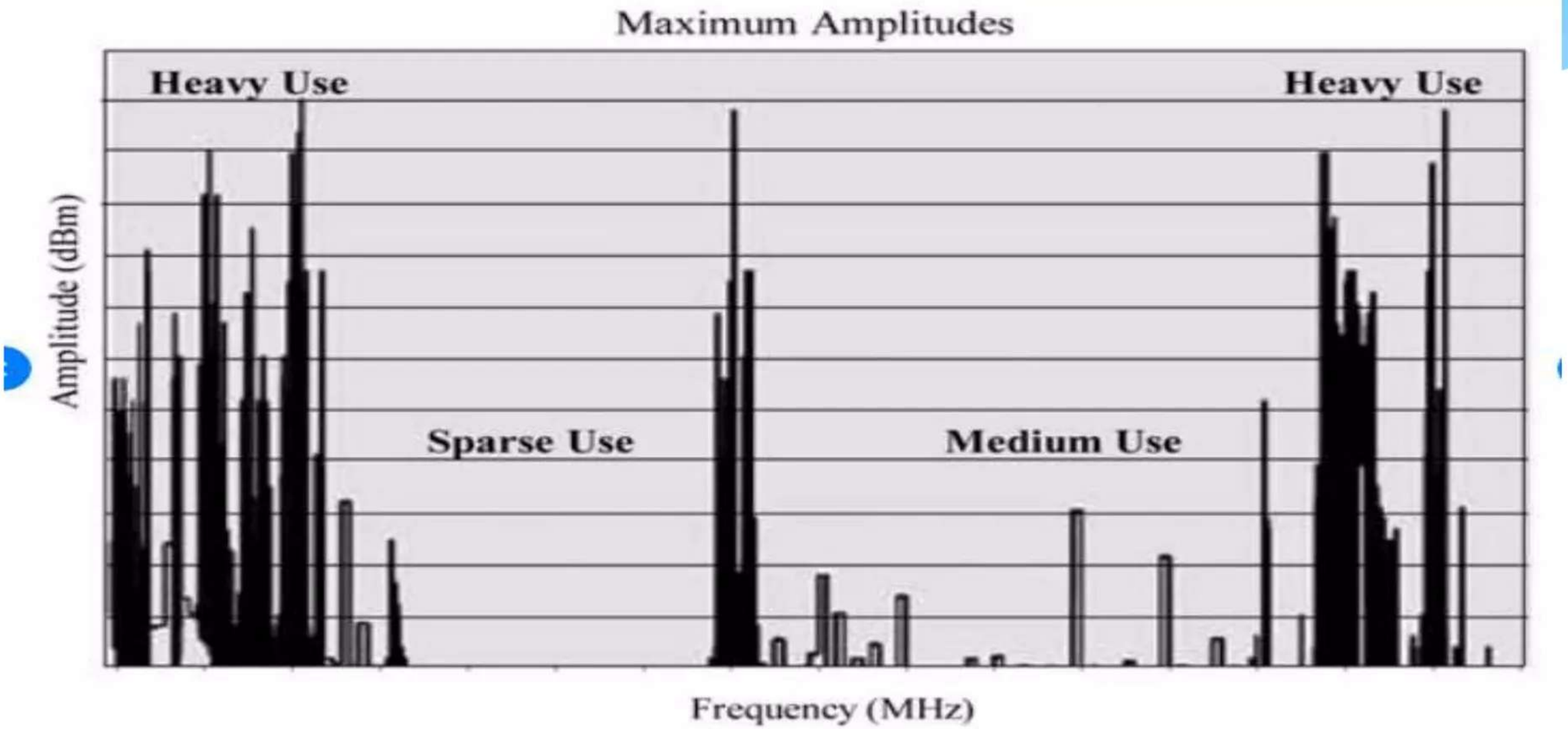


Spectrum utilization between 30 MHz and 3 GHz

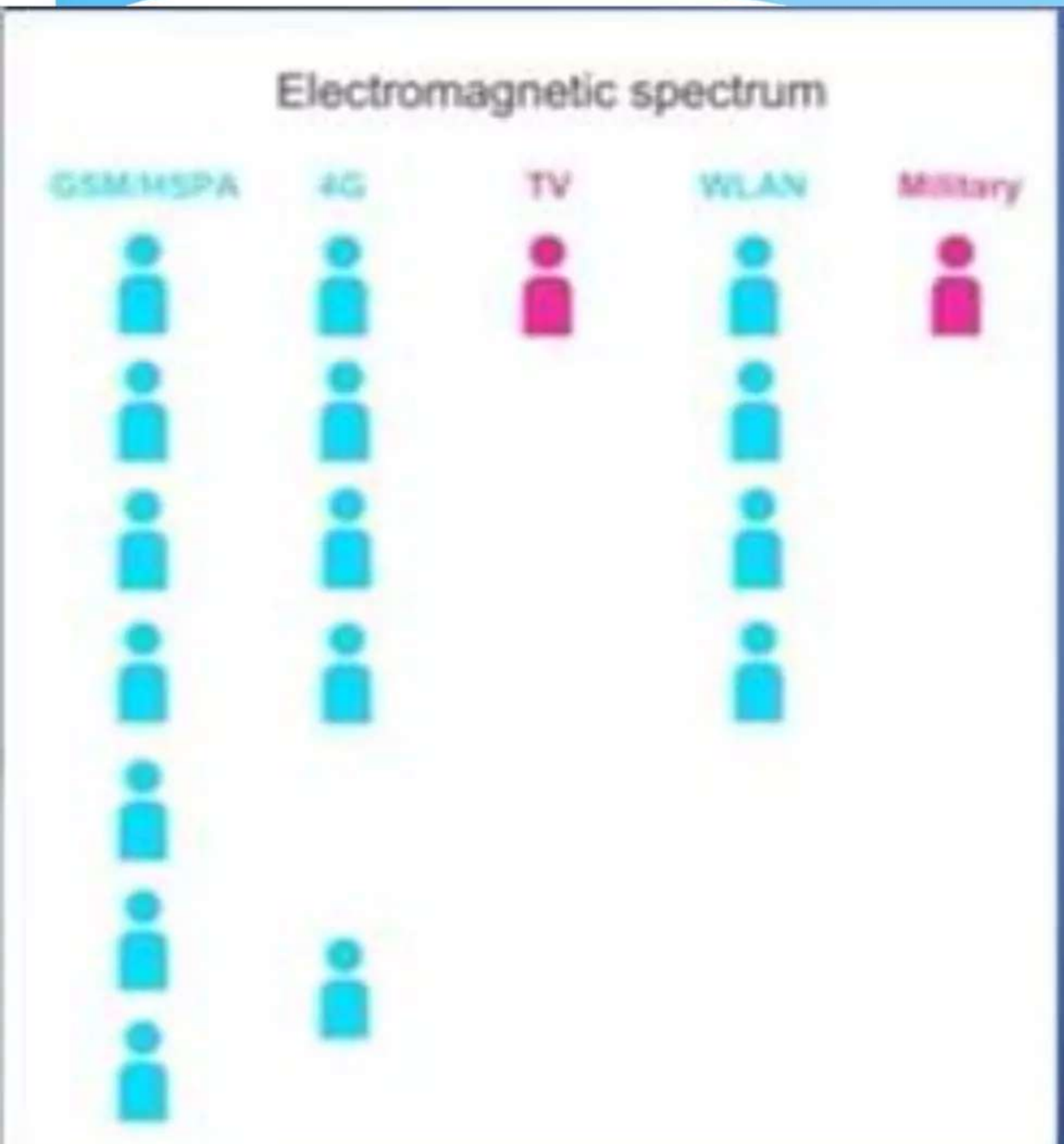
* The increasing number of mobile devices and the limited availability of radio spectrum is making it difficult for the existing wireless technologies to survive in today's world.
* Cognitive radio aims to solve the problem of spectrum scarcity by enabling opportunistic use of the radio spectrum.

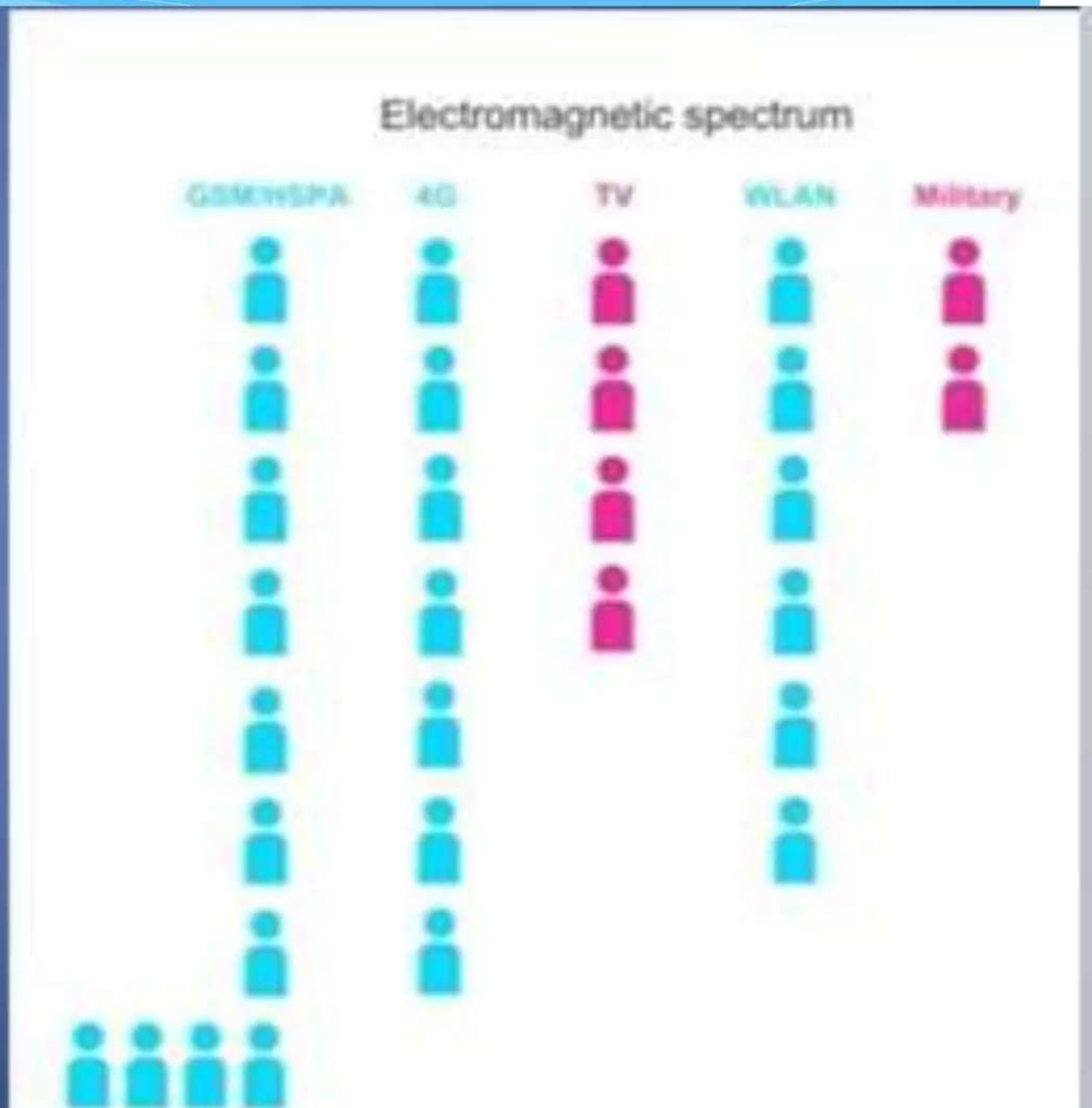
WHAT IS COGNITIVE RADIO

A **cognitive radio** (**CR**) is a radio that can be programmed and configured dynamically to use the best wireless channels in its vicinity, therefore avoiding user interference and congestion. Such a radio automatically detects available channels in wireless spectrum.

The transceiver can intelligently detect which communication channels are in use and which ones are not and then instantly moves into vacant channels, while avoiding occupied ones. These capabilities help optimize the use of the available radio frequency (RF) spectrum.

SPECTRUM INEFFICIENTLY USED





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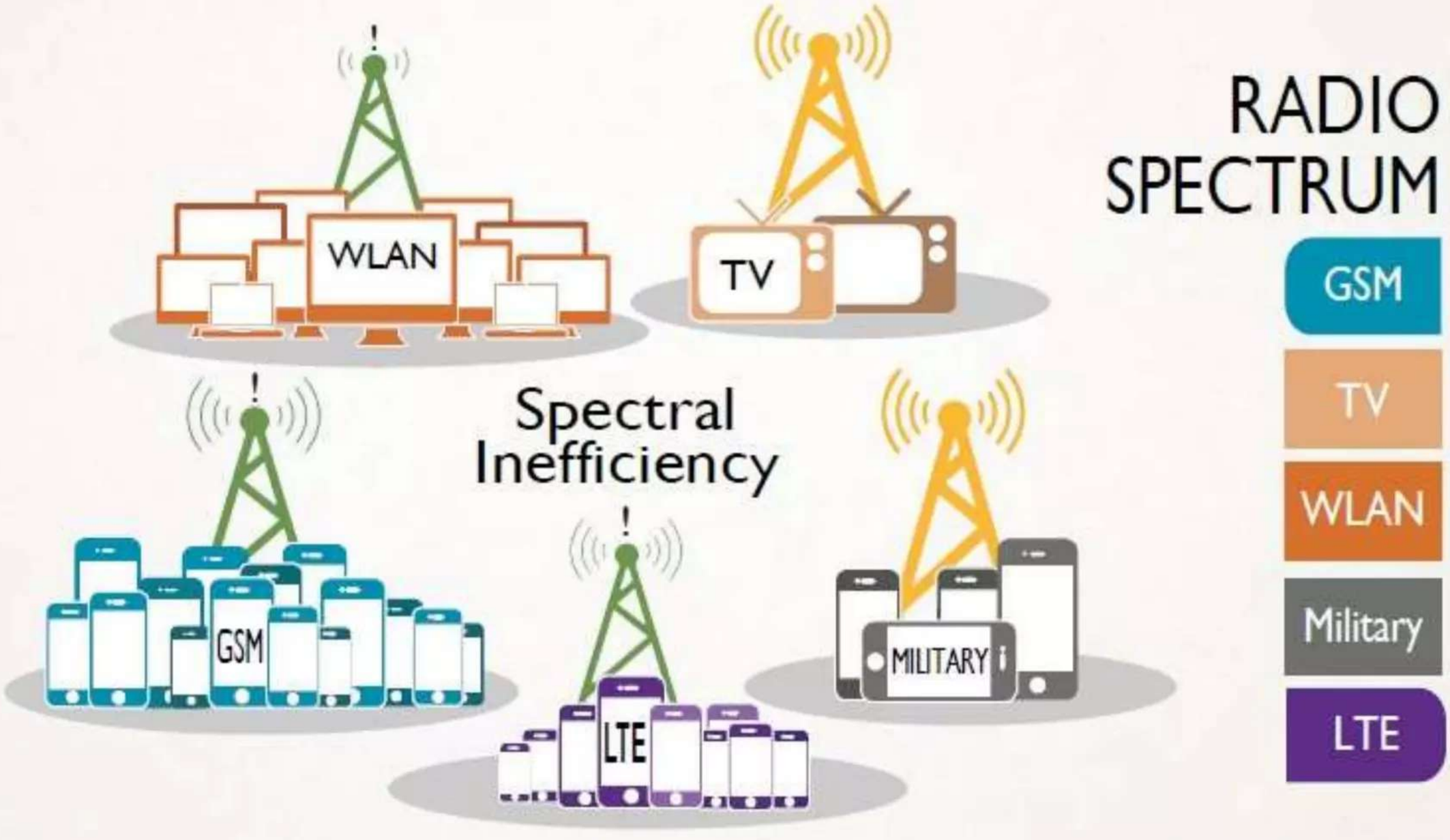


* With cognitive radio, unlicensed users can use licensed bands from users who are not currently utilizing their allocated frequency.

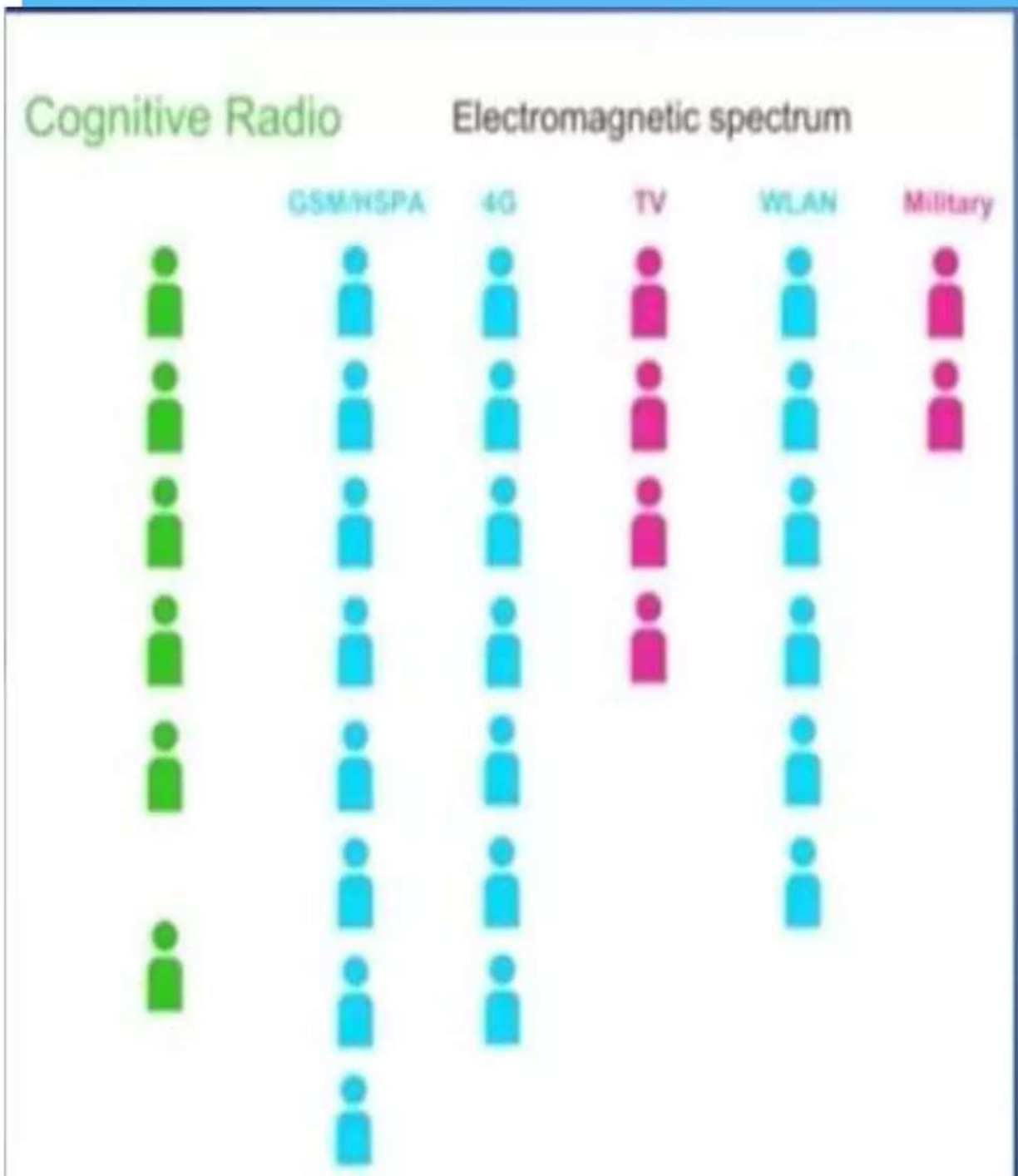
* This increases the spectral efficiency

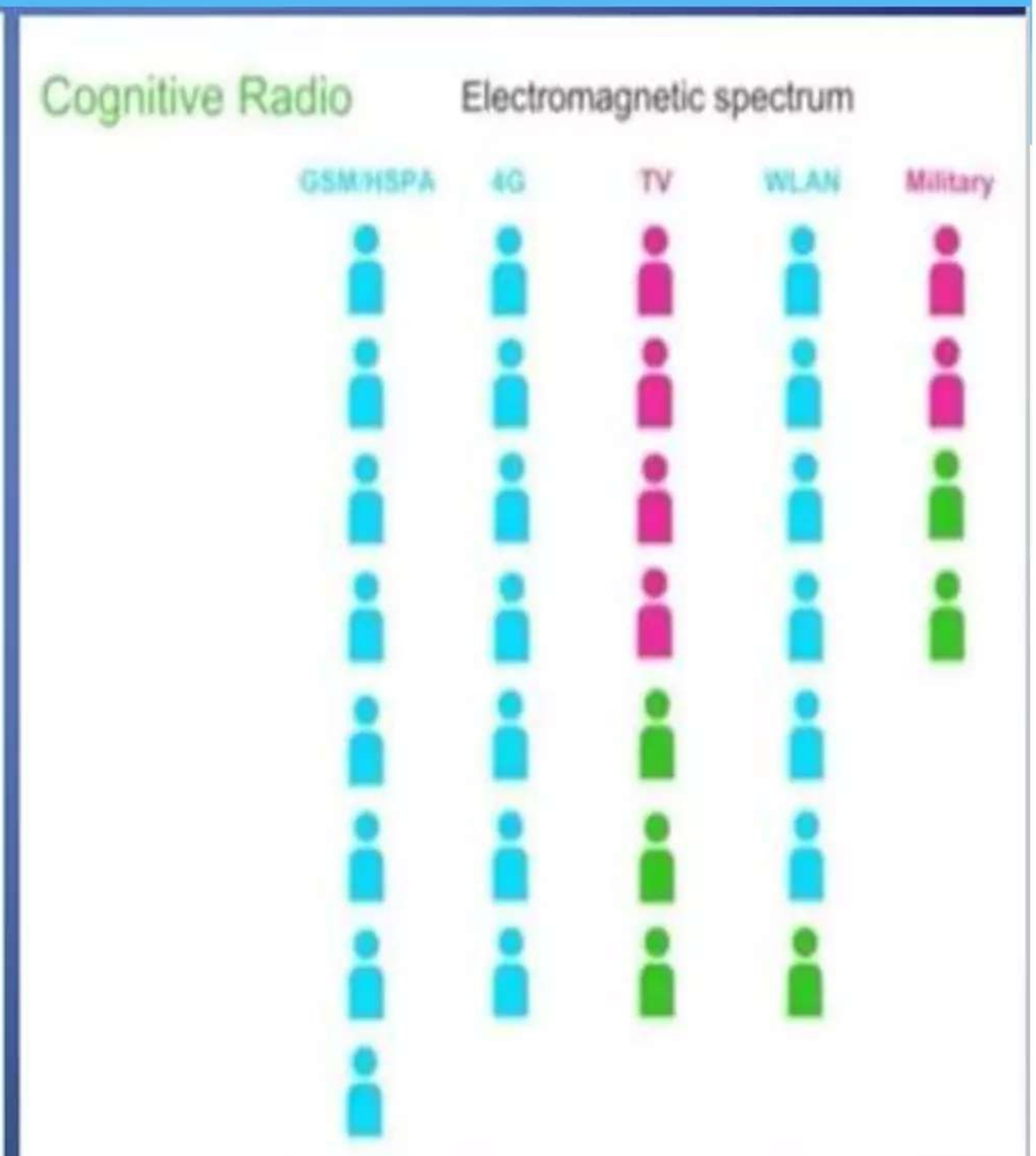
* Cognitive radio systems adapt dynamically to the changes in their operating environments

Cognitive radio provides

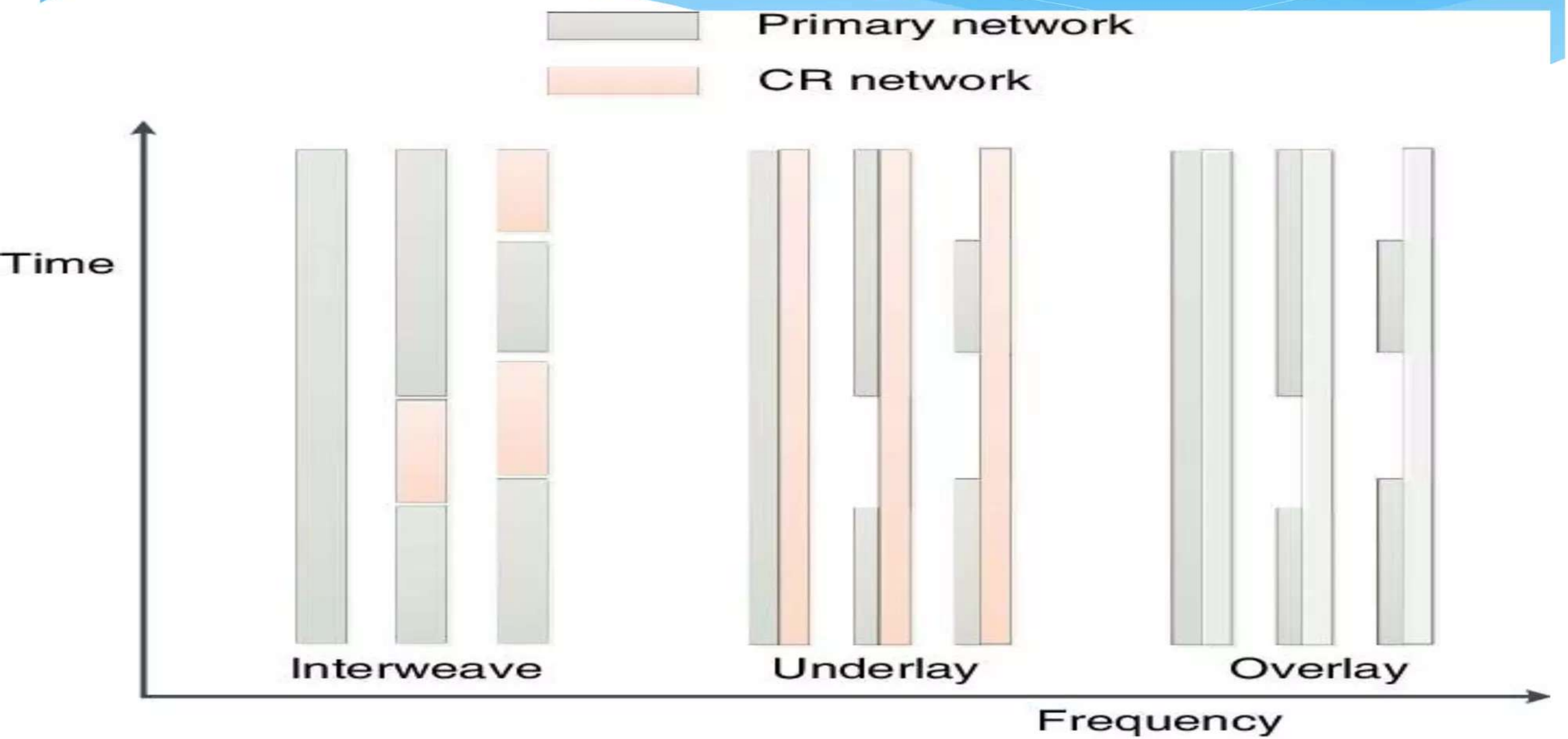
* spectral efficiency
* operational flexibility
* Adaptability according to the environment
* Interoperability between existing wireless networks

COGNITIVE RADIO





TYPES OF COGNITIVE RADIO

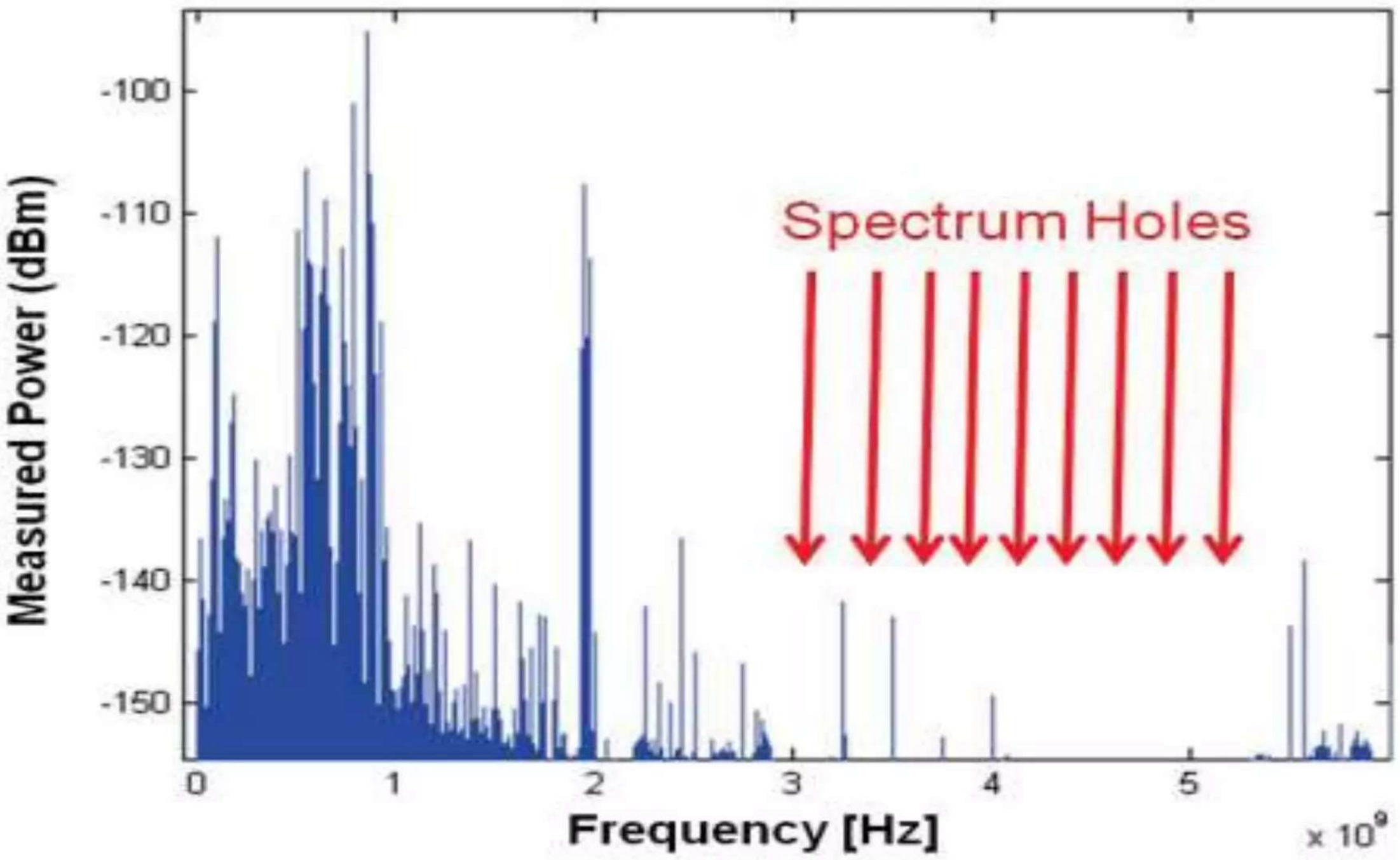


INTERWEAVE COGNITIVE RADIO

* Studies showed that a major part of the spectrum is not fully utilized most of the time.
* There exist temporary space-time-frequency voids, referred to as *spectrum holes* or *white spaces*, that are not in constant use in both the licensed and unlicensed bands
* The interweave cognitive radios opportunistically exploit spectral holes to communicate without disrupting other transmissions.

The interweave technique requires detection of primary (licensed or unlicensed) users in one or more of the space, time or frequency dimensions. This detection is quite challenging since primary user activity changes over time and also depends on geographical location.

SPECTRUM HOLES



ADVANTAGES

* It increases spectrum efficiency by automatically switching to other less busy frequencies.
* It improves the quality of service (QoS) for users by sensing environmental and inadvertent man-made radio interferences, cognitive radios can select frequency channels with a higher Signal to Noise Ratio (The higher the ratio, the better the signal quality)
* It also minimizes interference with other users.
* By predicting rain fade and reconfiguring transmitters/receivers for optimum bandwidth, cognitive radios improve communication quality when and where the information is needed most.

DISADVANTAGES

* It always requires **multi band antenna.**
* **Security.** There are more chances open for attackers in cognitive radio technology compared to traditional wireless networks.

COMPARISON

* In the **interweave system,** the cognitive radios opportunistically exploit spectral holes to communicate without disrupting other transmissions. Secondary users transmit simultaneously with a primary user only when there is missed detection of the primary user activity

* The **underlay system** allows cognitive users to operate if the interference caused to non-cognitive users is below a given threshold. Secondary users can transmit simultaneously with the primary users as long as interference caused is below an acceptable limit.

* In the **overlay system,** the cognitive radios use sophisticated signal processing and coding to maintain or improve the communication of non-cognitive radios while also obtaining some additional bandwidth for their own communication. Secondary users can transmit simultaneously with the primary users; the interference to the primary users can be offset by using part of the secondary users' power to relay the primary users' data sequences

Continuation…

* Interweave secondary user's transmit power is limited by the range of primary user activity it can detect.
* Overlay secondary users can transmit at any power, the interference to primary users can be offset by relaying the primary users' data sequences
* Underlay secondary user's transmit power is limited by a constraint on the interference caused to the primary users.

CONCLUSION

In conclusion, interweave cognitive radio is an intelligent wireless communication system that periodically monitors the radio spectrum, detects primary user occupancy over time, space, and frequency, and opportunistically communicates over spectrum holes with minimal interference to the primary users. Underlay and Overlay techniques permit concurrent primary and secondary user transmissions

The rise in popularity of cognitive radio networks in the telecommunication industry makes them one of the key enablers for 5G networks because they offer dynamic spectrum sharing.

THANK YOU !!!