1. What are wireless link metrics, and why are they pivotal for network performance? Explore the most commonly used metrics in wireless networks and their significance.

There are mainly four metrics that are used understand the wireless link strength. They are RSSI, SINR, PDR, BER(Law, 2008).

* RSSI (Received Signal Strength Indication): This metric measures the signal strength at the receiver's antenna as packets arrive. However, it only captures this during the packet preamble transmitted at the lowest rate, failing to account for interference that occurs later in the transmission process.
* SINR (SignaltoInterferenceplusNoise Ratio): SINR measures how the signal strength compares to the combined noise and interference at the receiver. While theoretically accurate, practical measurement challenges limit its utility because commercial hardware typically does not report SINR values in realtime.
* PDR (Packet Delivery Ratio): PDR calculates the ratio of packets received without errors to the total sent, reflecting overall link reliability. Its effectiveness, however, varies with packet size and transmission rate, which can lead to inconsistent evaluations of link quality.
* BER (Bit Error Rate): BER indicates the proportion of received bits that have errors. This metric offers a finegrained view of link integrity but requires repeated, detailed measurements, making it resourceintensive.

1. Discuss the complexities and challenges involved in accurately measuring wireless link metrics. Consider the impact of environmental factors, mobility, and interference.

Accurately measuring wireless link metrics like RSSI, SINR, PDR, and BER involves significant complexities due to environmental factors, mobility, and interference. The environment impacts wireless signals through obstacles which causes signal attenuation and multipath propagation, where signals take multiple paths to reach the receiver, complicating accurate measurement. Mobility introduces variability in signal strength and interference patterns as the relative positions of transmitters and receivers change, leading to fluctuating metric values. Interference, whether from cochannel or adjacent channel sources, further complicates measurements by introducing noise and signal overlap, which can reduce the link quality. The study highlights these challenges, particularly noting the difficulty in measuring SINR and the limitations of RSSI due to its inability to capture interference effects during high transmission rates. PDR's dependency on packet size and transmission rate also underscores the complexity of using it as a standalone metric in dynamic environments. These factors collectively demonstrate that no single metric can comprehensively assess link quality, suggesting the need for a composite approach to encompass the varying impacts of environmental dynamics, mobility, and interference.

1. Reflect on the evolution of wireless link metrics in the context of new wireless technologies (e.g., WiFi 6, 5G). Are there new metrics or methodologies on the horizon?

I think we can use PDR and BER from traditional wireless link metrics, which can be used for assessing the dependability and accuracy of the connection

The other metrics are:

* Latency: It is used for measures the time delay.
* Availability: It is used to assess network readiness to handle data requests.
* Spectral Efficiency: It tells, how well the spectrum is utilized.
* Energy Efficiency: It used to evaluate the power used relative to the amount of data transmitted.
* Network Density: The performance in dense device environments, reflects the growing IoT and smart device integrations.
* Quality of Experience: It considers user satisfaction.
* Interference: It gauges how well new wireless technologies perform alongside existing technologies.
* Security: It helps to measures of network security.

1. Share examples or case studies where understanding and optimizing wireless link metrics made a significant impact on network performance or user experience.

In this case study involving Indian Railways transitioning to a wireless system (Naskar, 2011), critical insights into wireless link metrics were derived. The study emphasized the use of Link Quality Indicator (LQI) to ensure robust wireless connections across railway platforms. This metric was key in managing the asymmetry of link qualities due to environmental variables and hardware inconsistencies, which can severely impact performance in short-range wireless networks. By setting a threshold LQI value, the system maintained high reliability and minimized the typical discrepancies in signal reception across different devices. This approach not only stabilized the network but also provided a scalable model for assessing and enhancing wireless link quality in complex industrial environments. The results demonstrated that precise control and monitoring of link quality metrics could significantly boost the efficiency and reliability of critical communication infrastructures.

References:

1. Vlavianos, A., Law, L., Broustis, I., Krishnamurthy, S., & Faloutsos, M. (2008). Assessing link quality in ieee 802.11 wireless networks: which is the right metric? <https://doi.org/10.1109/PIMRC.2008.4699837>
2. Rohankar, A., Naskar, M., & Mukherjee, Amitava. (2011). short range wireless network: a real time case study. international journal of research and reviews in wireless sensor networks, 1(vol 1). <https://www.researchgate.net/publication/267789135_Short_Range_Wireless_Network_a_Real_Time_Case_Study>