Understanding RF Values in the LTE environment

Deciphering LTE signal performance can be confusing. Signal strength, quality and noise interference all play a critical part in the overall performance of your voice and data capabilities. Understanding the signal values and the metrics used to measure them is fundamental when integrating any 4G node.

		SINR (dB)	RSRQ (dB)	RSRP (dBm)	EC/Io (dB)
	Technology	LTE Only	LTE only	LTE only	HSPA+ and EVDO
Signal Quality	Excellent	> 12.5	> -5	> -84	> -2
	Good	10 to 12.5	-9 to -5	-85 to -102	-2 to -5
	Fair	7 to 10	-12 to -9	-103 to -111	-5 to -10
	Poor	< 7	< -12	< -111	< -10

		RSSI
	Technology	LTE and 3G
Signal Strength	Excellent	> -65
	Good	-65 to -75
	Fair	-75 to -85
	Poor	<-85

(Fig 1)These values display one representation only. Different technologies and transmitting mediums may vary the results and interpretations of the above reference table:

4G Value Metrics

- **SINR/SNR** – The signal-to-noise ratio of the given signal.
- **RSRP** – The average power received from a single reference signal, and Its typical range is around -44dbm (good) to -140dbm(bad).
- **RSRQ** – Indicates quality of the received signal, and its range is typically -19.5dB(bad) to -3dB (good).
- **RSSI** – Represents the entire received power including the wanted power from the serving cell as well as all co-channel power and other sources of noise and it is related to the above parameters through the following formula:

SINR- *Signal-to-Noise Ratio*

SINR indicates the ratio between the wanted signal and the unwanted noise.

Represented as the equation: $\boldsymbol{snr} = \frac{\boldsymbol{Signal\ Power}}{\boldsymbol{Noise\ Power}}$

Simply put, the power of a signal does not represent the quality of the signal. A signal can be strong and loud but if saturated with unwanted noise, it will be substandard.

SNR can be either a positive or negative value represented in the dB scale. Negative SNR means that Signal power is lower than the noise power.

In general a SINR level in the positive range is desirable. However, some communications systems are designed to work in negative conditions. These types of systems rely on certain pass-through protocol that allows for long distance voice communication with limited packet transfer e.g, CDMA, WCDMA).

RSRP-**Reference Signal Recieved Power**

Reference signal received power (RSRP), is defined as the linear average over the power contributions of the resource elements that carry cell-specific reference signals within the considered measurement frequency bandwidth.

This may sound a little overwhelming but the main element of comprehension is this:

RSRP is the total received power across the entire bandwidth and averaged across a measurable reference metric (dBm) RSPR gives an indication of the signal strength of the desired signal but does not give an indication of signal quality.

RSRP

RSRP	Signal strength	Description
>= -80 dBm	Excellent	Strong signal with maximum data speeds
-80 dBm to -90 dBm	Good	Strong signal with good data speeds
-90 dBm to -100 dBm	Fair to poor	Reliable data speeds may be attained, but marginal data with drop-outs is possible. When this value gets close to -100, performance will drop drastically
<= -100 dBm	No signal	Disnonnection

RSRQ

RSRQ	Signal quality	Description
>= -10 dB	Excellent	Strong signal with maximum data speeds
-10 dB to -15 dB	Good	Strong signal with good data speeds
-15 dB to -20 dB	Fair to poor	Reliable data speeds may be attained, but marginal data with drop-outs is possible. When this value gets close to -20, performance will drop drastically
<= -20 dB	No signal	Disconnection

RSSI (Recieved Signal Strength Indicator)

RSSI is the total power observed across the whole band including the desired signal as well as non-serving signal and co-channel interference and thermal noise.
RSSI is best understood at the overall volume of the RF signal within the receivable band.

RSRQ(Reference Signal Recieved Quality)

RSRQ is the metric used to measure the quality of the received reference (measurable) signal. This signal quality is determined by the number of resource Blocks (n) over which Received Signal Strength Indicator(RSSI) is measured.

RSRQ perhaps the most difficult metric to understand.

Only Cell(BS)-Specific Resource blocks can be occupied in order to obtain reportable RSRQ. As such, RSRQ measurements are not captured in real-time as a mapping algorithm is applied in order to provide accurate readings.

In short, RSRQ readings are dependent on a continual transfer of usable signal and traffic transfer and handover must be mitigated.

Mathematically, RSRQ is represented as: $\boldsymbol{RSRQ} = {}^{\boldsymbol{RSRP}}/_{(\boldsymbol{RSSI}/\boldsymbol{n})}$

The Determining Factors of Signal Values

There are many different factors that influence signal strength and quality; these factors include, but are not limited, to the following:

- Proximity to the cellular tower
- Tower load
- Physical barriers (mountains, buildings, trains, etc.)
- Competing signals
- Weather
- Signal going through a cellular repeater

Signal Strength and Signal Quality numbers do not incorporate all of the relevant factors. Keep in mind that measurements of Signal Strength and Signal Quality for a specific moment do not reflect on the STABILITY of a connection, as these values will vary as conditions change.