TD-LTE: Greater Flexibility, New Challenges

TD-LTE is the 4G upgrade path for operators with unpaired spectrum, bringing increased capacity, flexibility, and data throughput rates to markets around the world. In most respects, TD-LTE works the same as LTE FDD. However, where FDD transmits uplink and downlink on separate frequency bands, TD-LTE alternates between uplink and downlink on a single frequency band (see **Figure 1**). TD-LTE gives operators two key advantages: 1) TD-LTE enables LTE to function without the need for paired spectrum allocations; and 2) TD-LTE allows operators to devote resources to uplink and downlink asymmetrically, freeing capacity for downlink data-intensive applications such as streaming video.

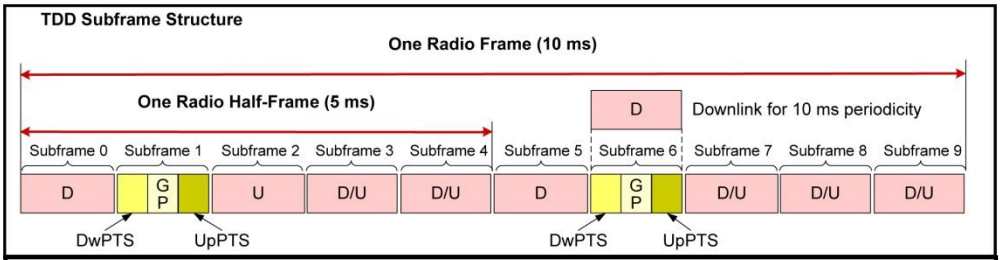

Figure 1: TDD Subframe Structure. The TD-LTE subframes types are Downlink (D), Uplink (U), and special subframe. Parts of the special subframe include Downlink Pilot Time Slot (DwPTS), Guard Period (GP), and Uplink Pilot Time Slot (UpPTS).

These advantages, however, introduce network configuration challenges. First, TD-LTE requires time-synchronization between base stations. If sectors are not properly synchronized, handover problems may result, including dropped sessions. Secondly, to prevent overlap between uplink and downlink signaling, TD-LTE uses a Guard Period (GP, as shown in **Figure 1**) in which no data is transmitted. The GP occurs inside the special subframe, which also includes a variable amount of downlink information in the Downlink Pilot Time Slot (DwPTS) and uplink signaling in the Uplink Pilot Time Slot (UpPTS). To avoid overlap, the length of the GP must take into account both the size of the sector and potential interference from neighboring cells. If the DwPTS extends too far into the subframe, data and control signaling may be lost.

Third, asymmetrical signaling adds further system complexity and must be coordinated among multiple cells to avoid interference problems. TD-LTE uses seven different Uplink-Downlink Configurations (**Figure 2**) to determine how the frame will be divided between uplink and downlink. These configurations include options for 5 ms or 10 ms switching periodicity, with 5 ms switching requiring a second special subframe.

APPLICATION NOTE

SeeGull® Measurements and Parameters for TD-LTE

SeeGull scanning receivers include the following specialized TD-LTE measurements and parameters designed to provide detailed network performance data as well as key information for verifying TD-LTE parameters.

Top N Measurements: Featuring **high dynamic range** for all Uplink-Downlink Configurations. SeeGull's Top N parameters also include CINR, path measurements of multiple Tx antenna ports, Reference Signal measurements of the full LTE bandwidth, and subband measurements. Reference Signal Time Offset measures the time differential between the beginning of the LTE frame and each second of GPS time, allowing engineers to verify network time synchronization.

Uplink-Downlink Configuration: Automatically detects which subframes are devoted to downlink and uplink and reports the associated configuration number for verification purposes (see **Figure 2**).

DwPTS Symbol: Reports the last symbol number used by the Downlink Pilot Time Slot (DwPTS) within the special subframe (see **Figure 1**). In combination with base station location information, DwPTS Symbol can be used to identify downlink signaling that overlaps the recommended GP.

Uplink-Downlink Configuration	Downlink to Uplink Switch Periodicity	Subframe Number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

D Subframe for downlink transmission
S Special subframe for guard time
U Subframe for uplink transmission

Figure 2: TDD Uplink-Downlink Configurations

LTE Power Analysis: Measures power levels of individual slots and Resource Blocks (RBs). LTE Power Analysis allows engineers to troubleshoot time or frequency-selective issues.

SeeGull's measurements and parameters are designed to provide an accurate picture of TD-LTE networks, allowing engineers to identify configuration errors while optimizing performance. Since both Uplink-Downlink and special subframe Configurations must be set with inter-cell interference in mind, SeeGull's high-dynamic range measurements also provide key information for determining optimal TD-LTE configurations. PCTEL scanning receivers can smooth TD-LTE launches and aid optimization efforts, helping operators and end-users alike to reap the full benefits of this exciting new technology.

APPLICATION NOTE