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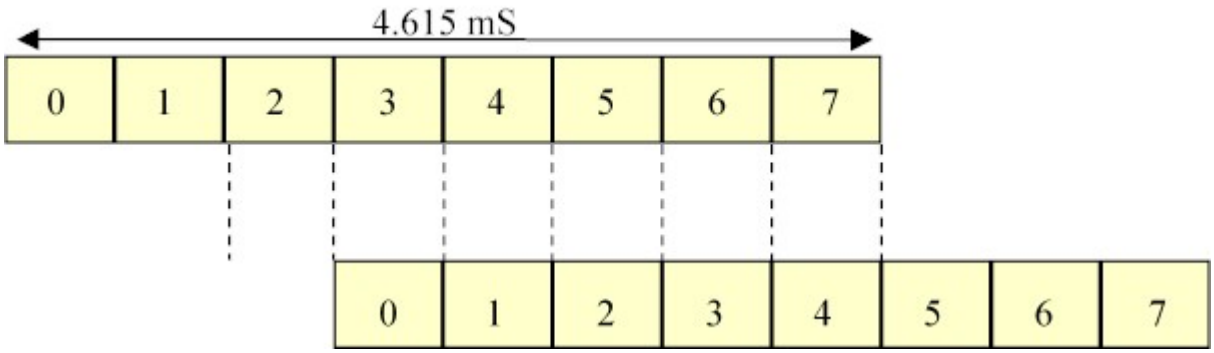
GPRS Design

One of the main objectives of GPRS (general packet radio service) is to provide bandwidth on demand by using more than one time slot per 8 slot frame. The diagram below shows how the time slots are presently arranged in the GSM uplink and downlink.

GSM Air Interface - Frame



8 Time Slots

- Mobile active in 1 time slot
- Same Time slot receive but with a 3 slot frame off-set to provide time division duplex protection in addition to 45 MHz RF duplex separation (ie two spare time slots of spare between Tx and Rx).
- Uses 6 spare time slots to measure signal strength on 5 adjacent base stations and its own base station.

Using one time slot per frame, the user ends up with a data rate of 14.4 k/bps (this is increased from the standard 9.6k/bps by borrowing back some of the embedded error correction). Dedicating two slots on the uplink or downlink therefore opens up 28.8k/bps, dedicating 8 slots opens up 115kbps.

An 8 slot terminal is however a very different animal from today's single slot terminal. In effect an 8 slot terminal is more or less equivalent to implementing a base station but in a terminal form factor.

Firstly, instead of a one in eight duty cycle, the terminal has to sustain a two in eight or eight in eight duty cycle giving a pro rata increase in power consumption and a pro rata increase in power dissipation. Given that we have to design the hardware for the worst case operating condition, this means the terminal has to be capable of delivering a continuous two watts at 900MHz (class 4) or one watt at 1800 MHz. Given that it is difficult to get RF PA efficiency much beyond 55-60%, this presents a

very special challenge both in terms of power supply design, battery energy density and RF PA packaging.

A second consideration is the loss of receive sensitivity implied by the use of multiple tx and rx slots in each frame. Looking at the diagram above you will see that there is a 3 slot time off set between the uplink and downlink. This time space between transmit and receive greatly eases the design of the front end filtering in the phone to the extent that the front end duplex filter has been replaced by a switch in many current phone designs.

However, if more than 2 time slots are used, the time space duplexing disappears and the sensitivity is once again dependent on the re-adoption of RF duplexing.

An additional complication is that the spare rx time slots in the terminal are used to measure 5 adjacent base stations, gathering information which is then sent back to the network to provide the basis for handover decisions. Locally generated tx power getting into these rx measurement slots will compromise/invalidate the whole maho (mobile assisted handoff) process.

The design problem gets worse when you consider multi-band phones. Given that we have just said how useful it is to do without the lossy, expensive and large duplex filter, we now have to find room for three of them.

Many multi-band design solutions are moving towards using off set phase locked loop (modulated loop) design architectures. This is an elegant way of implementing dual band and tri-band requirements but is completely incompatible with GPRS implementation. We will be covering this architecture in our next hot topic section..

Last but not least, GPRS has a fundamental impact on synthesiser design. In a standard GSM mobile, the synthesiser has the slot offset time to settle. In GPRS, the synthesiser has to settle on a slot by slot basis (if all slots are used)/which requires either two synthesisers(expensive and power hungry) or some quite exotic speed up techniques. Either way the real challenge for GPRS is how to implement the hardware without an insupportable increase in component count and cost.

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