Adaptive Power Control Module in Cellular Radio System

Final Report

EE 382C Embedded Software Systems

Jianhua Gan

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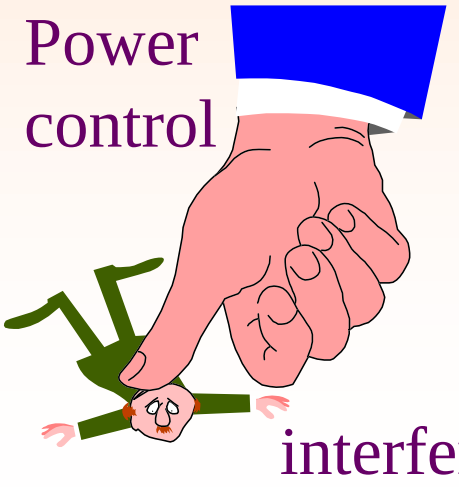
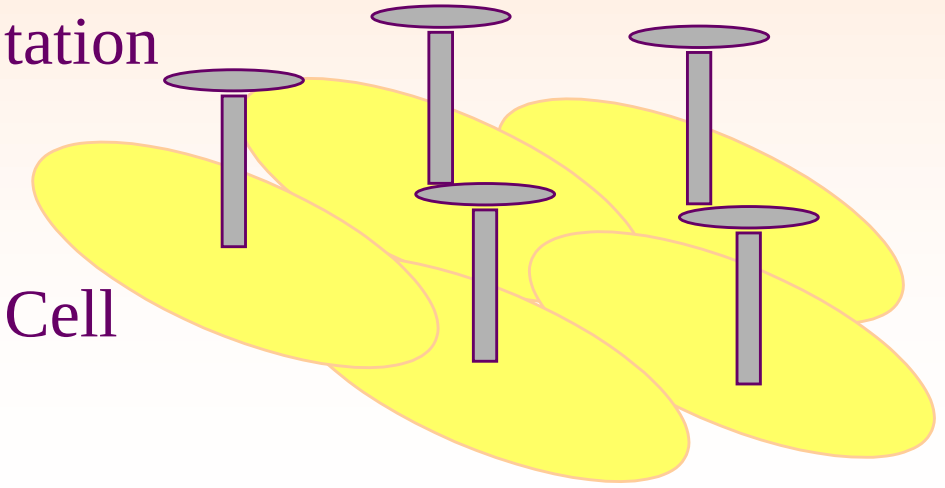
Why Power Control ? -motivation

- **All CDMA (code division multiple access) signals interfere with each other**
- **Reduce the interference:**
  - **co-channel (Multi-path fading)**
  - **cross-channel (imperfect technology)**
- **Maximize capacity and fairly allocate limited resources among different users**



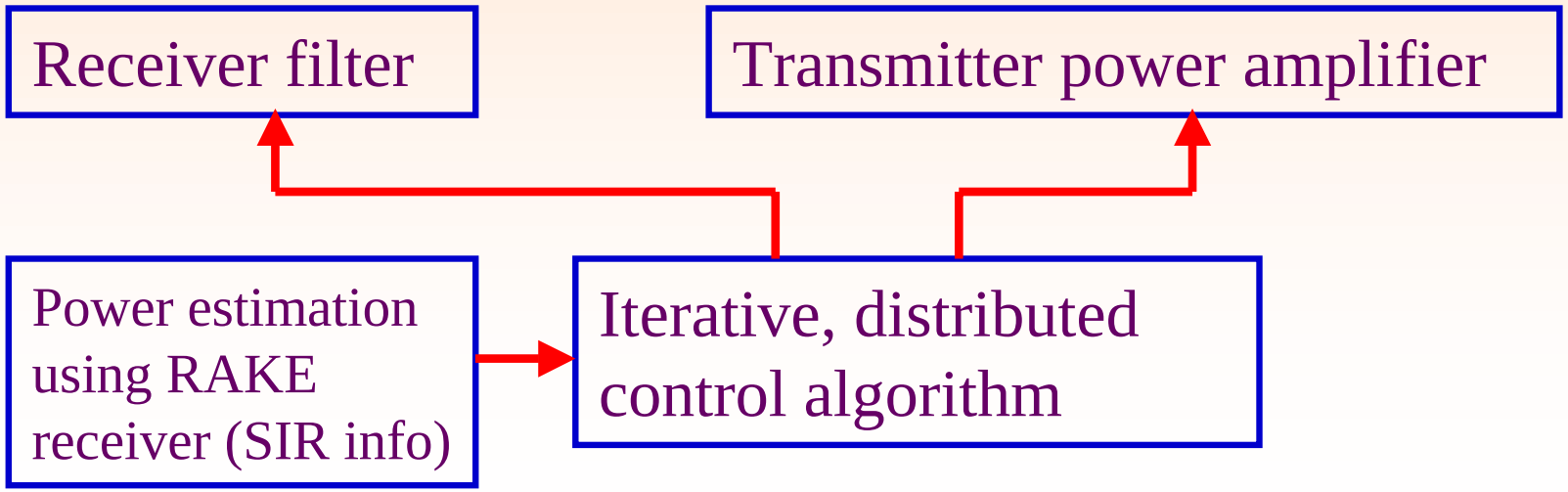


Objective of Power Control:

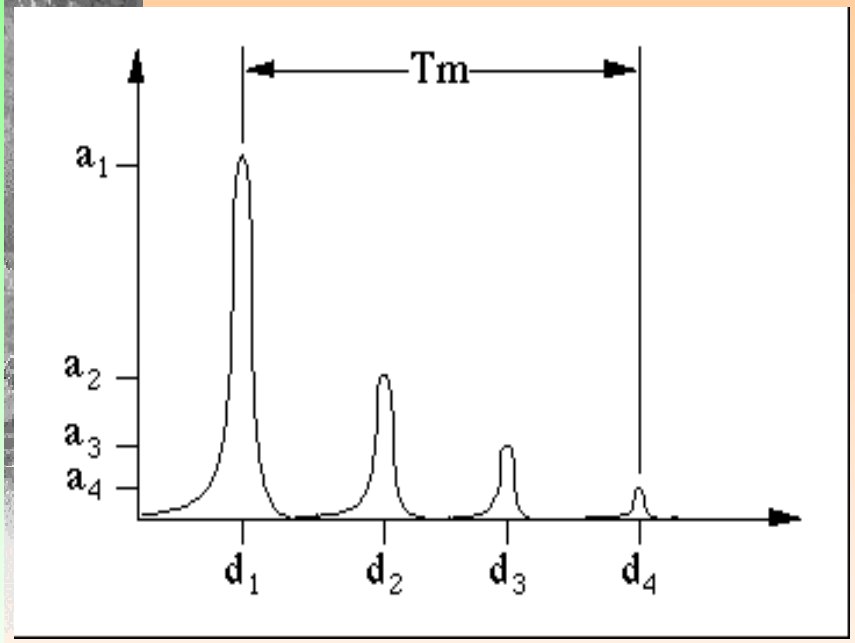
- **Use optimal power level to minimize the interference while meeting certain Quality of Service (QoS) objectives such as Signal to Interference Ratio (SIR) and Bit Error Rate (BER).**
- **Additional advantages:**
  - **Increase capacity**
  - **Reduce battery drain and increase possible talk time**

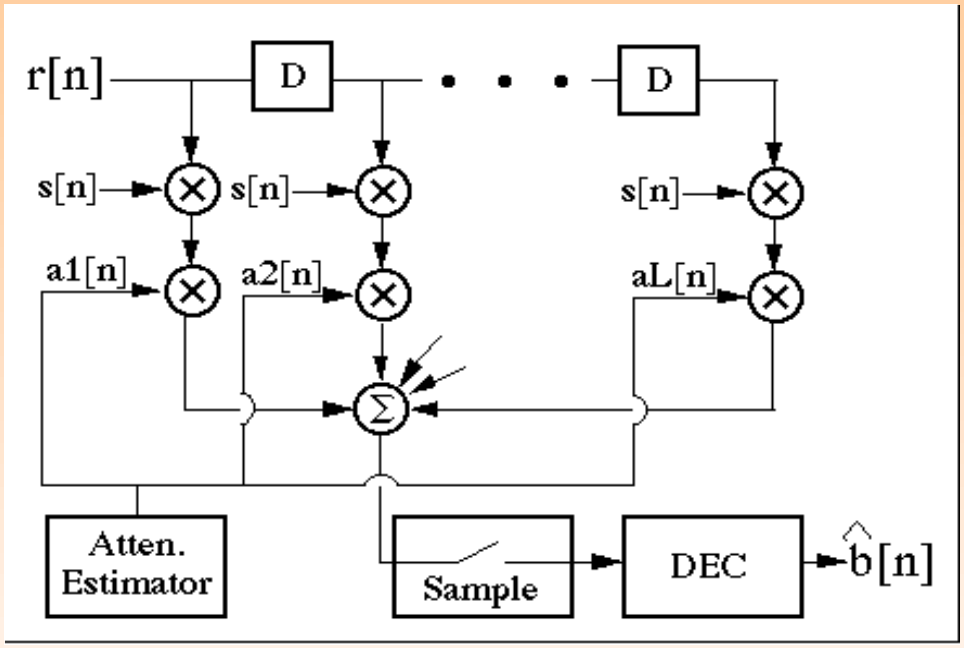
Adaptive Power Control (1)

- **A better solution with higher convergence rate and increased capacity:**
  - **Adapt the receiver filter coefficients to suppress the interference optimally**
  - **Adaptively control the transmitter power to create minimum possible interference**



Adaptive Power Control (2)





Problems:

Multi-path fading

Interference

Solution:

Adaptive RAKE receiver with path attenuation (power) estimation

Adaptive Power Control (3)

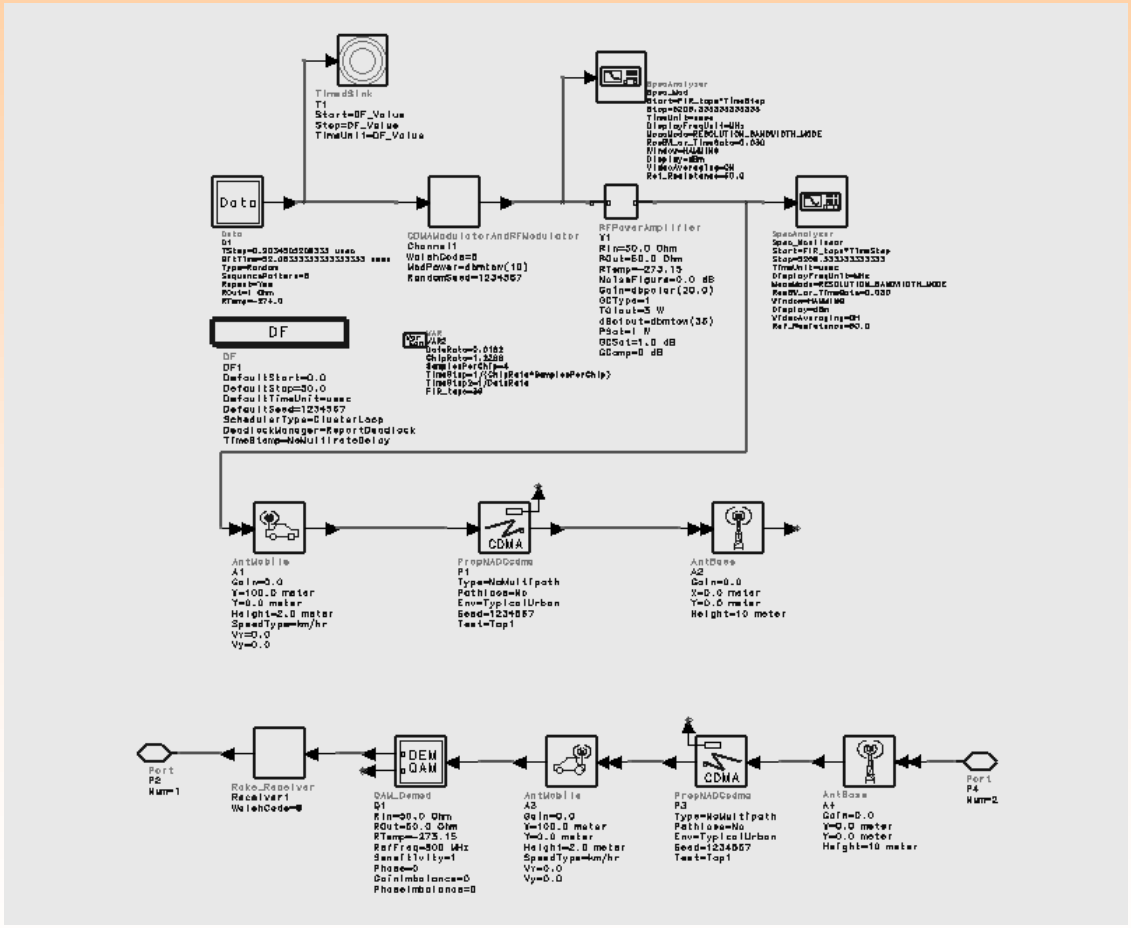
- **Models of computation:**
  - **Synchronous Dataflow**
    - **Filters**
  - **Analog Circuits (SPICE model, behavior)**
    - **Power amplifier**
  - **Timed Synchronous Dataflow (TSDF)**
    - **Circuit Envelope (RF circuit)**

HP Advanced Design System

- HP ADS allows the co-simulation and co-synthesis of heterogeneous designs: Communication System designs with DSP and RF/Analog circuits.
- We can simulate the whole mobile system with the antenna and propagation model in HP ADS(license not available) and test our design in this virtual environment.

Implementation in HP ADS

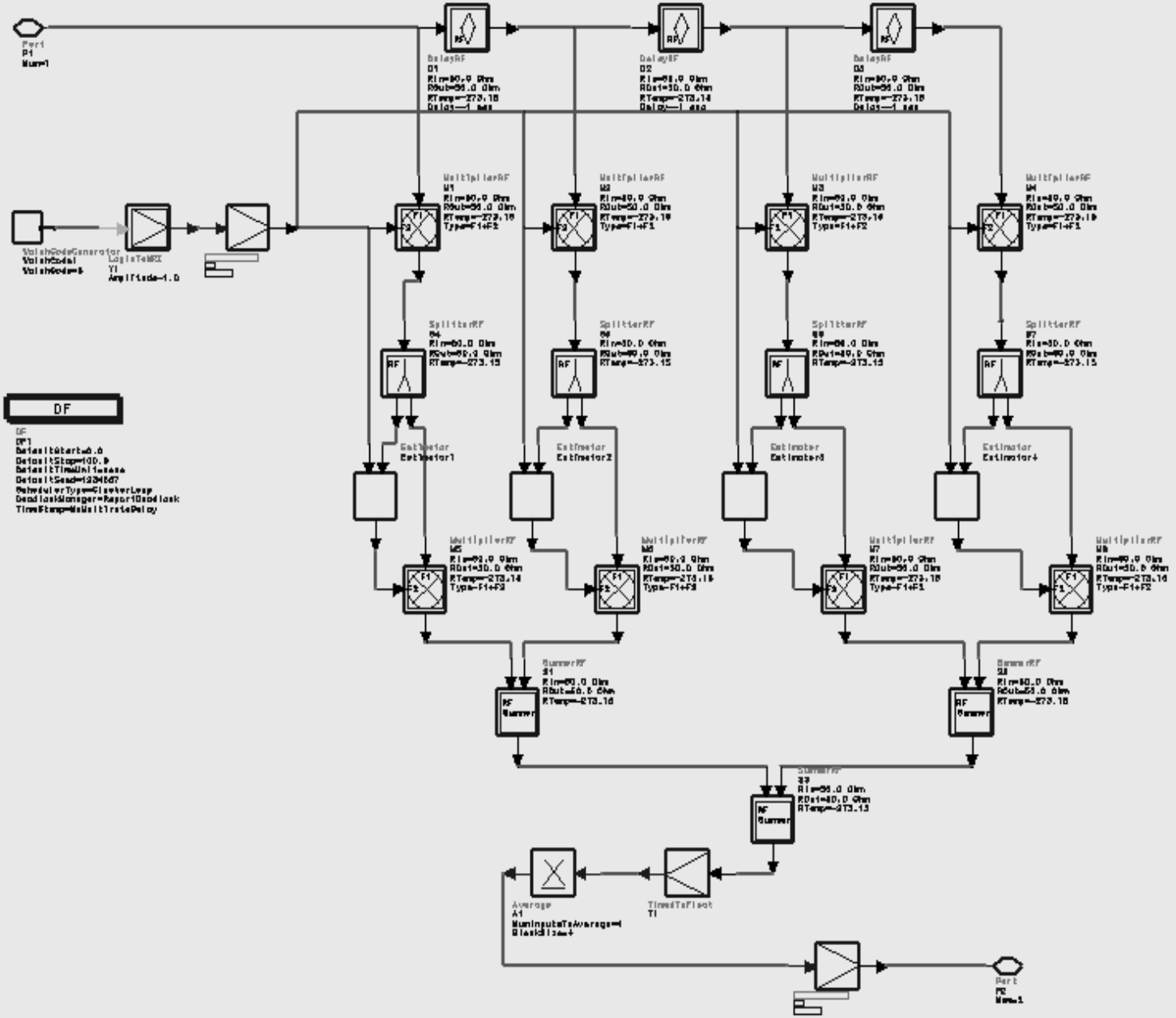
Top Level:



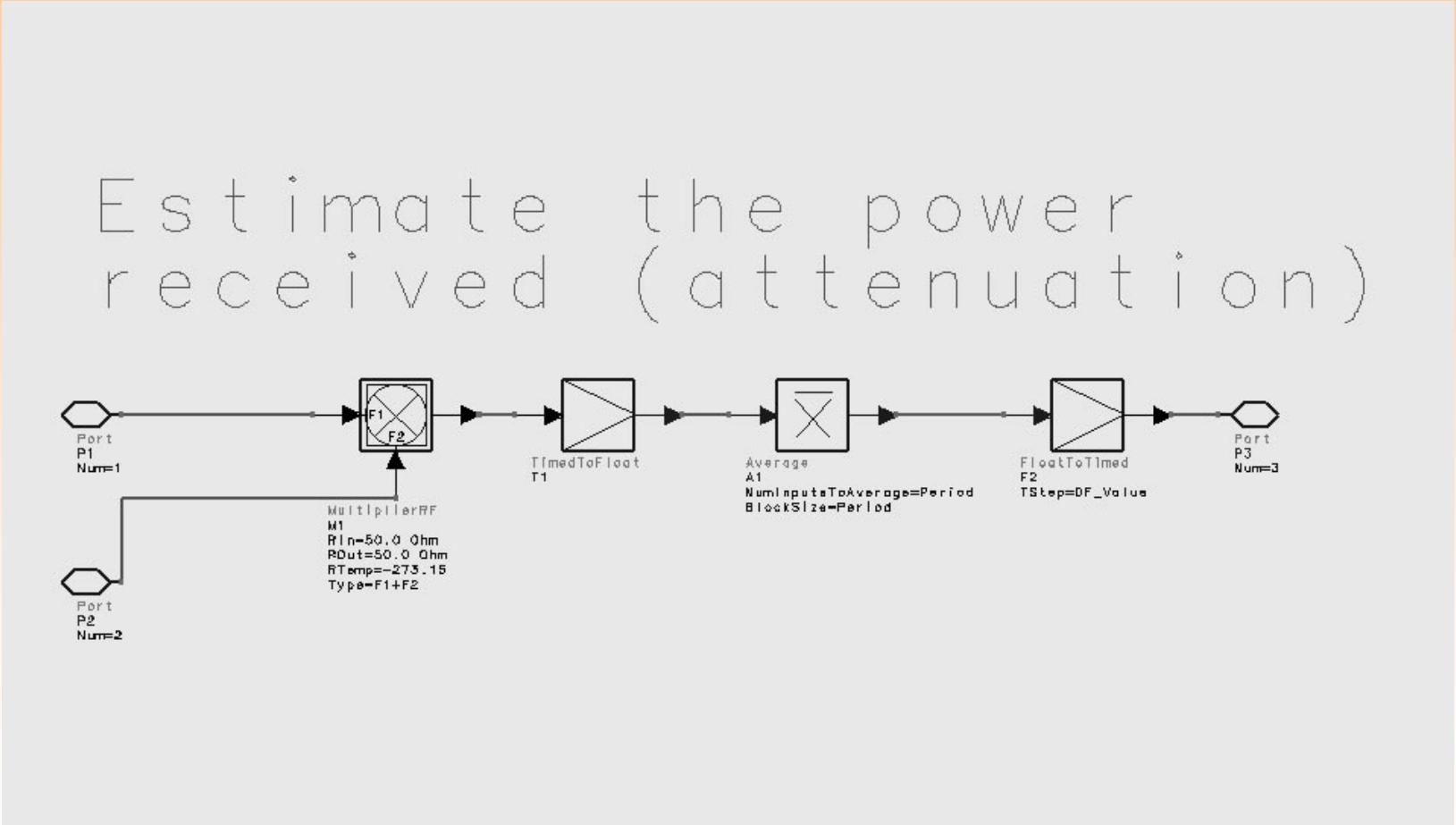
Adaptive RAKE Receiver and Amplifier

- RAKE receiver adjusts its own parameters based on the power estimation it made.
- The gain of the transmitter power amplifier is adjusted based on RAKE receiver's estimation

Adaptive RAKE Receiver with Power Estimation



Power estimation:



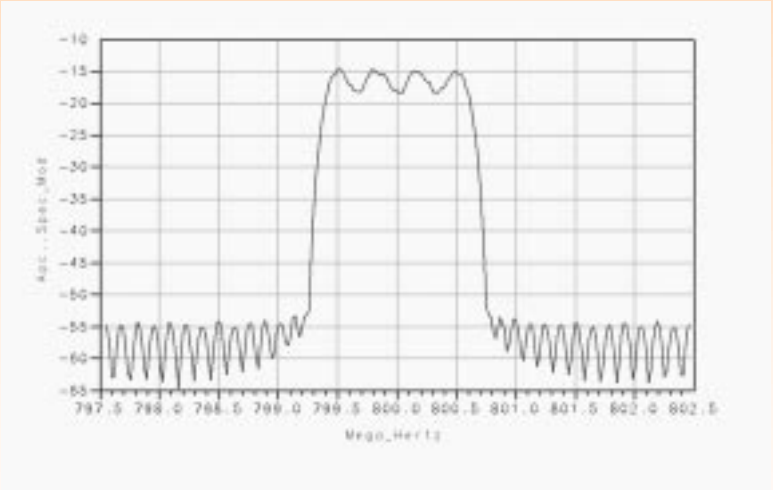
Saved a lot of components by sharing with receiver

Some Results:

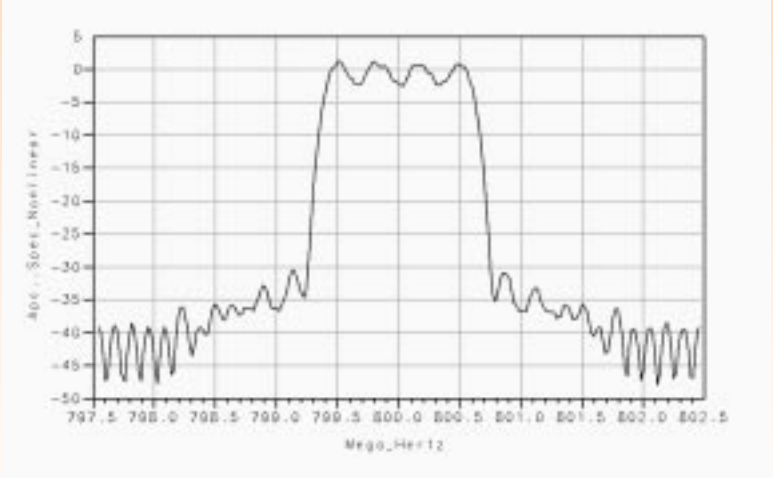
Transmitter was built using components in ADS.

Base band data rate 19.2kHz, Chip rate 1.2288MHz,

RF carrier frequency: 800MHz, Spreading code 64bits



Before amplifier



After amplifier

Simulation:

- Matlab simulation shows the convergence of RAKE receiver coefficients
- Full simulation in HP ADS is not available at this time

Thoughts:

- Use Timed SDF model and RF/Analog model to do the co-simulation for power control module in mobile system.
- We can put many mobiles and base stations in HP ADS environment so that we can test how the design functions.
- Synthesize the design in HP ADS.