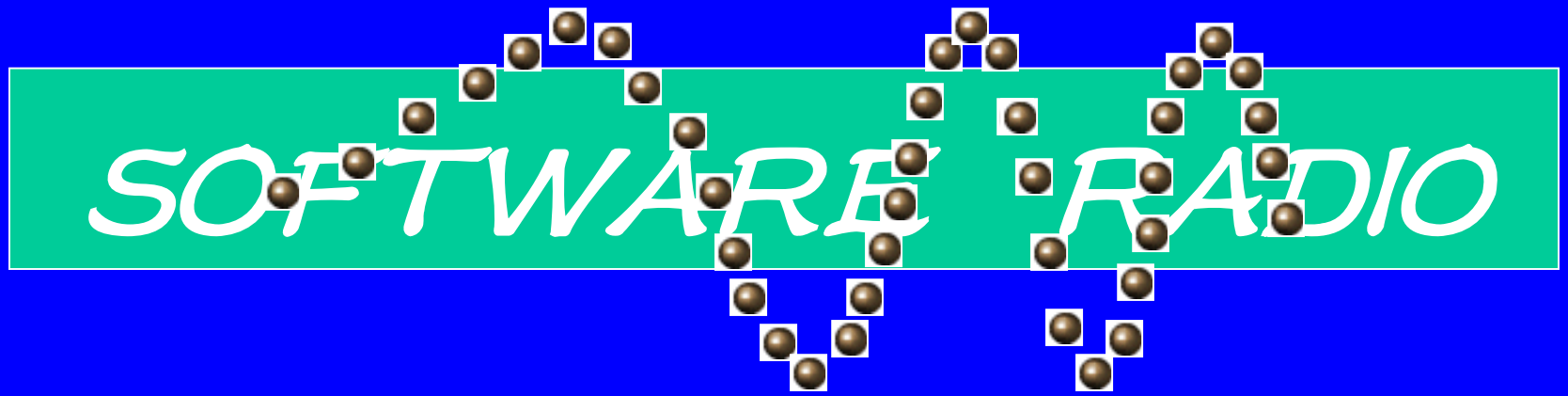
软件无线电

—原理与应用



第一章　绪论

一、什么是软件无线电（Software Radio)

1. 定义（Definition)

软件无线电是将模块化、标准化的硬件单元以总线方式连接构成基本平台，并通过软件加载实现各种无线通信功能的一种开放式体系结构。

Software radio is a radio where essential radio parameters like frequency range, modulation type, maximum output power etc. can be altered by changing software.

2. 软件无线电的主要特征（Hallmarks)

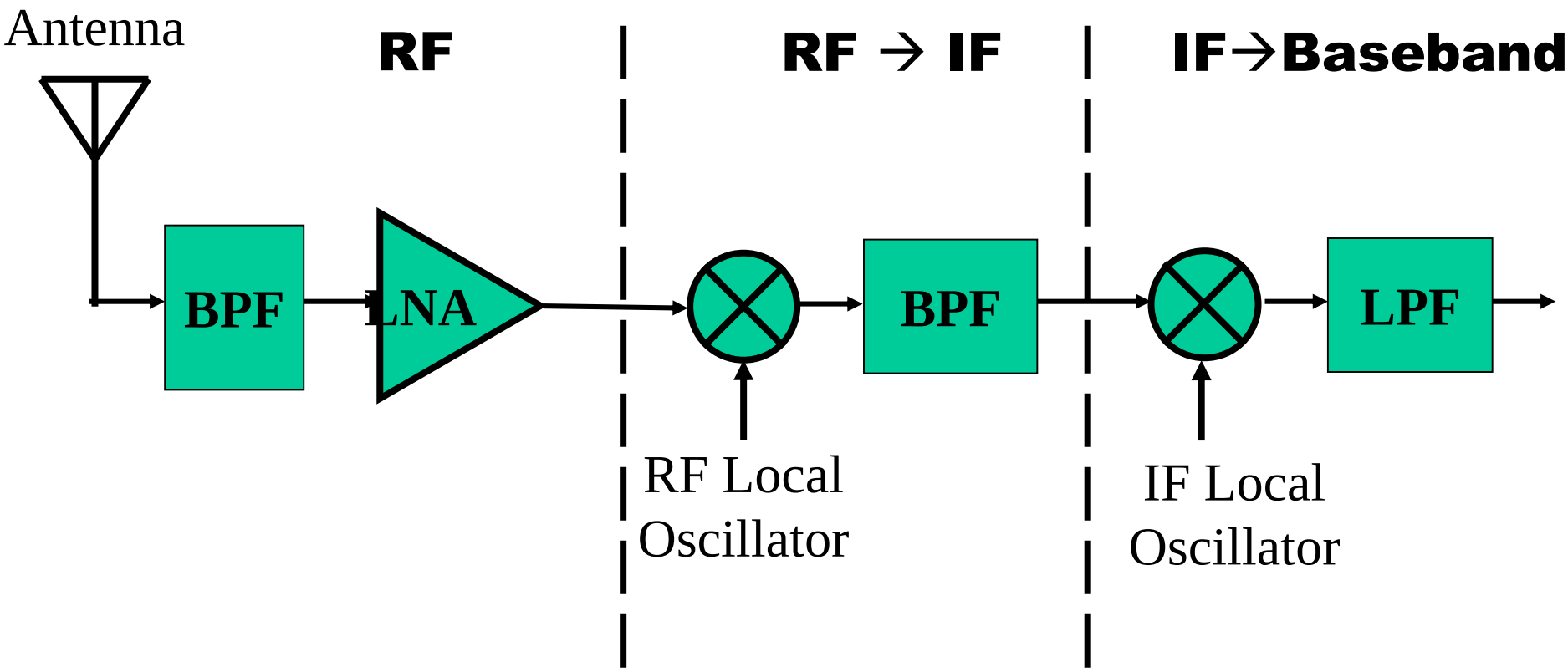
▲ 将A/D, D/A尽可能靠近天线

as near as possible to the antenna

▲ 用软件定义无线电功能

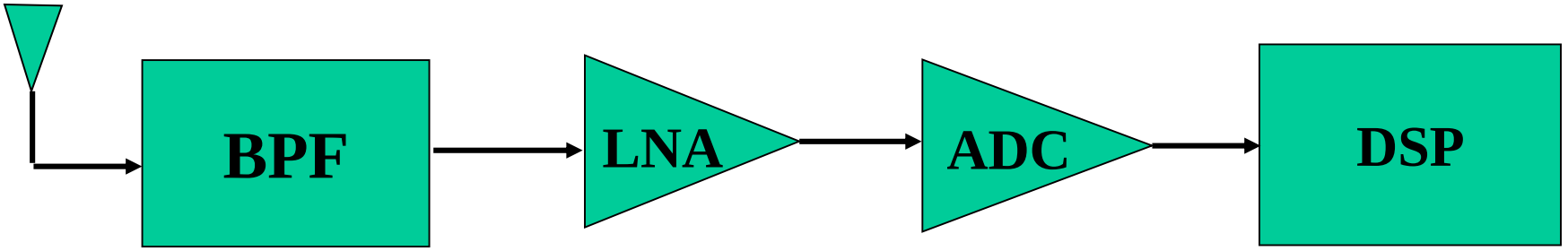
as many radio functionalities as possible in software

A Traditional Receiver:



Super-heterodyne Receiver

An Ideal Software Radio Receiver:



二、软件无线电的关键技术(Key Technologies)

1. 开放式总线结构(Architecture Openness)

- ▲ PCI/CPCI总线
- ▲ VME总线
- ▲ MTCA

(Micro Telecommunications Computing Architecture)

2. 智能天线（Smart Antenna)

- ▲ 天线能覆盖所有的工作频段
- ▲ 能用程序控制的方法对功能和参数进行设置

3. 模数转换(Analog-Digital Conversion)

▲高速A/D、D/A

▲高采样精度：80dB的动态范围要求不低于12位的分辨力

4. 高速数字信号处理能力(High-Speed DSP)

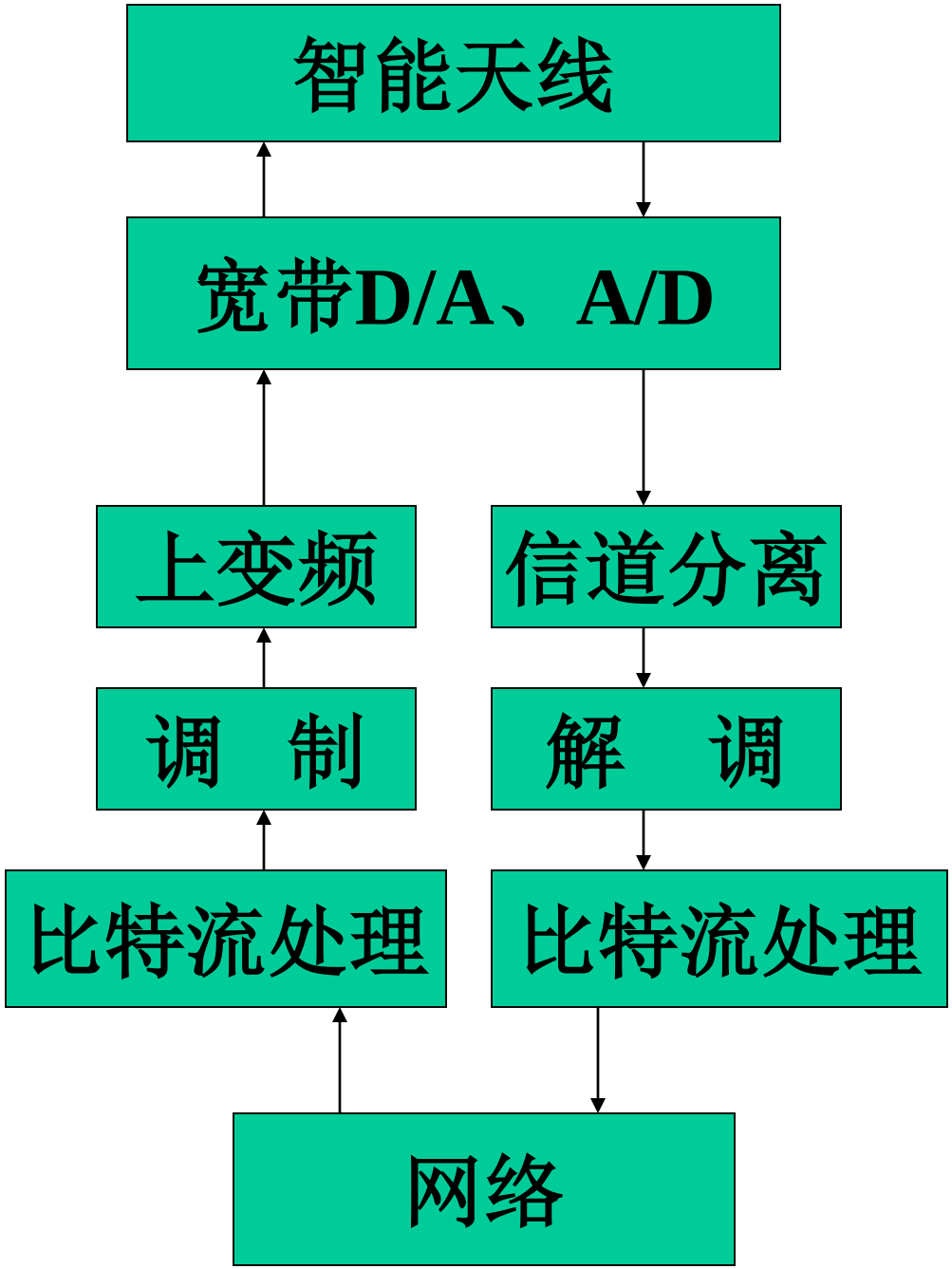
▲数字下变频

▲调制解调/基带信号处理

▲比特流处理： FEC和交织等

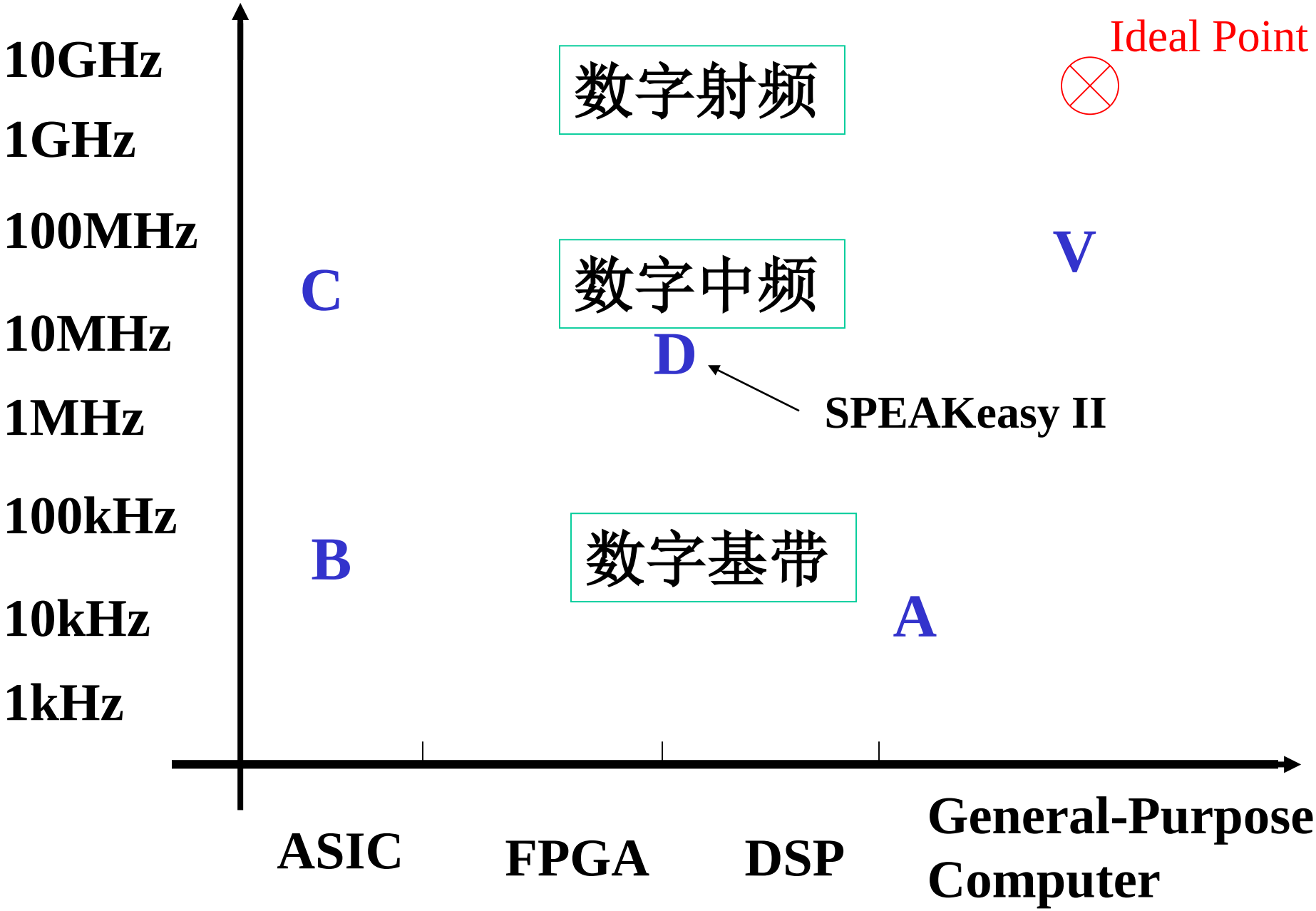
5. 信令处理(Signaling Processing)

▲通信协议及软件标准化、通用化和模块化


智能天线
宽带D/A、A/D
上变频
信道分离
调　制
解　调
比特流处理
比特流处理
网络

三、软件无线电演化

1. 软件无线电状态空间示意图(Phase Space)

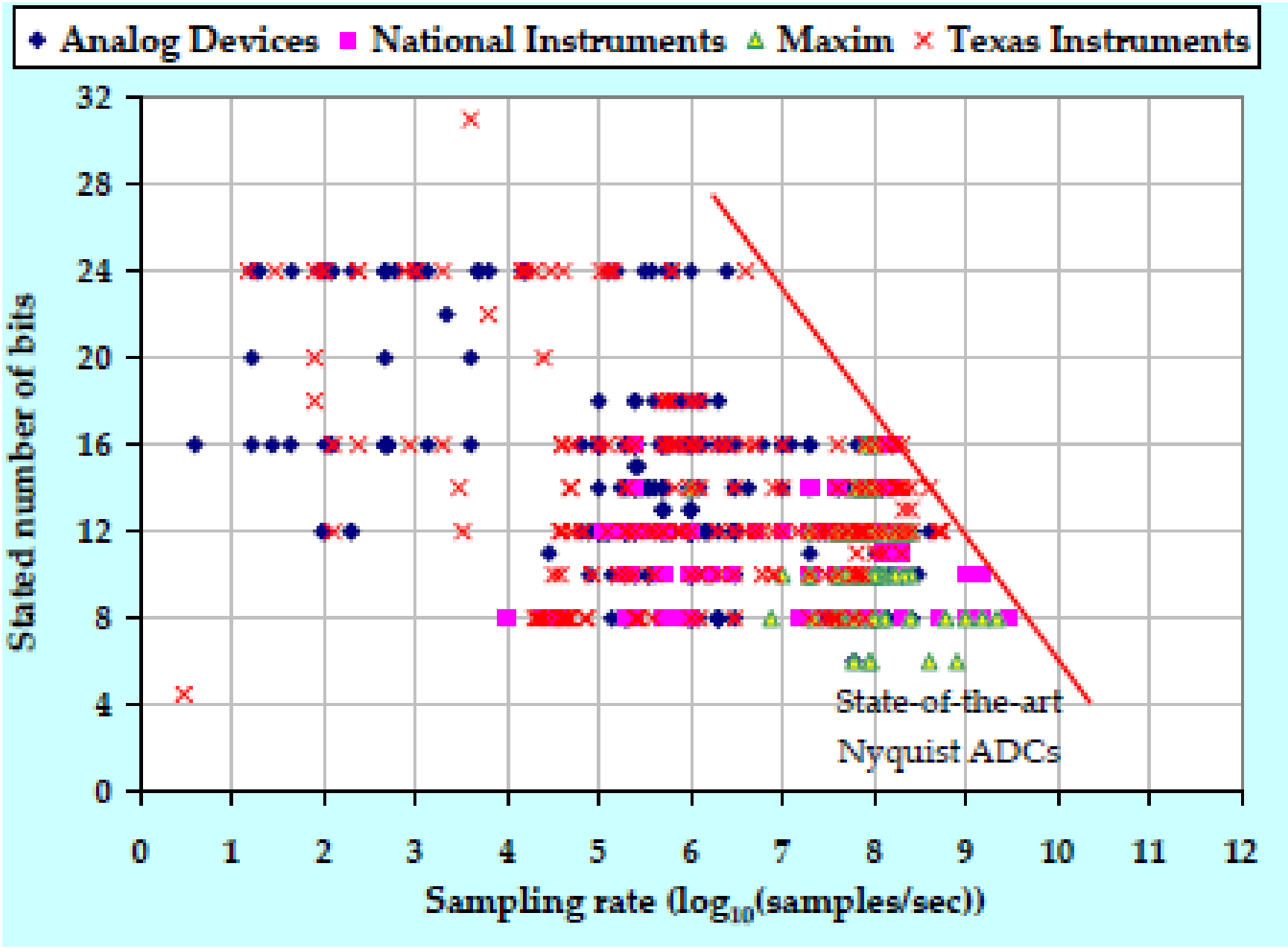


(1)如果2.5GHz带宽的信号A/D转换以后的处理全部由通用微机完成，则可得到一个理想的软件无线电接收机(Ideal Software Radio Receiver)。

(2)实现这样一个理想的软件无线电接收机目前受到以下限制(Limitations)：

- 超高速的A/D转换器动态范围只有30dB
- 通用微机不具备对数据率达5GHz的信号进行处理的能力
- 没有一个单一的天线或RF级能支持从2MHz-2.5GHz的模拟带宽

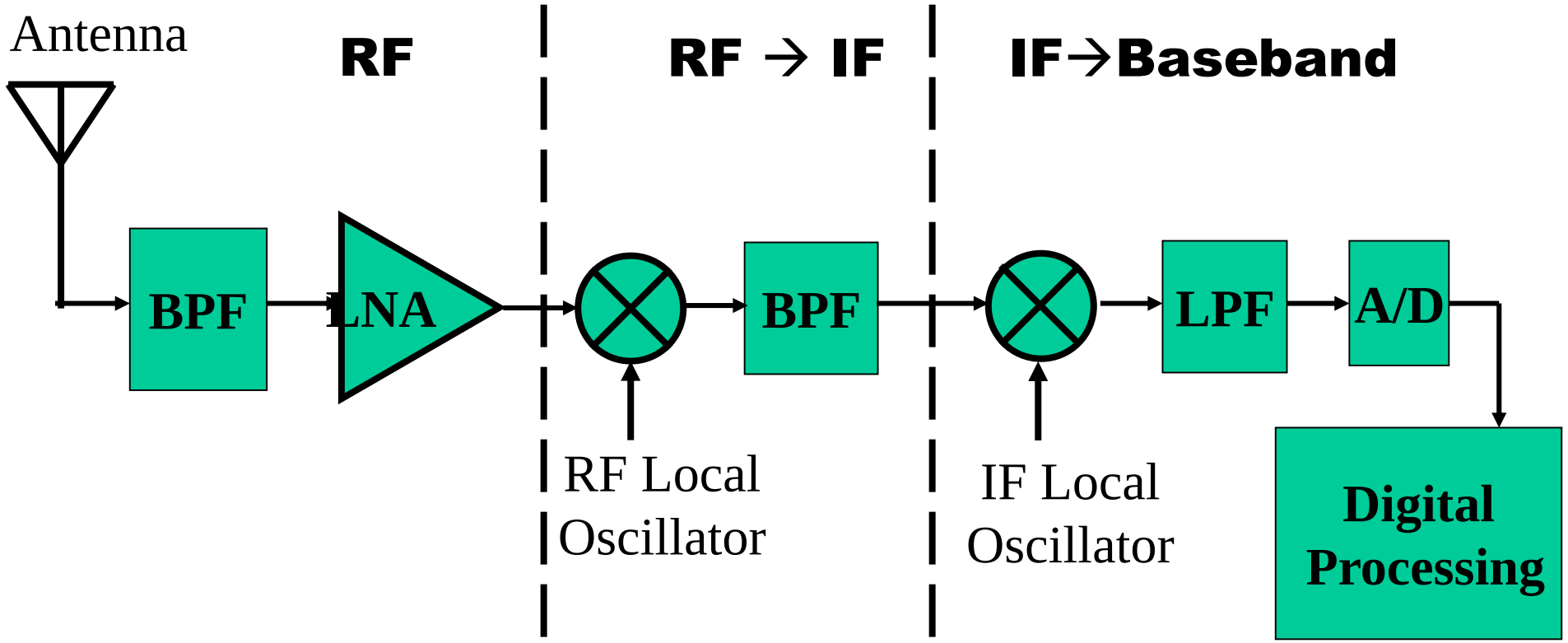
(3) 理想的软件无线电为我们提供了一个参考点


Analog Devices
National Instruments
Maxim
Texas Instruments
Stated number of bits
Sampling rate (log10(samples/sec))
State-of-the-art
Nyquist ADCs
0
4
8
12
16
20
24
28
32
0
1
2
3
4
5
6
7
8
9
10
11
12

2. Evolutionary Path to an SW Radio Terminal

Step 1:

- RF/IF sections are realized with analog circuits
- Process channel and source coding by **ASICs**
- Baseband modem is realized by **DSPs or FPGAs**

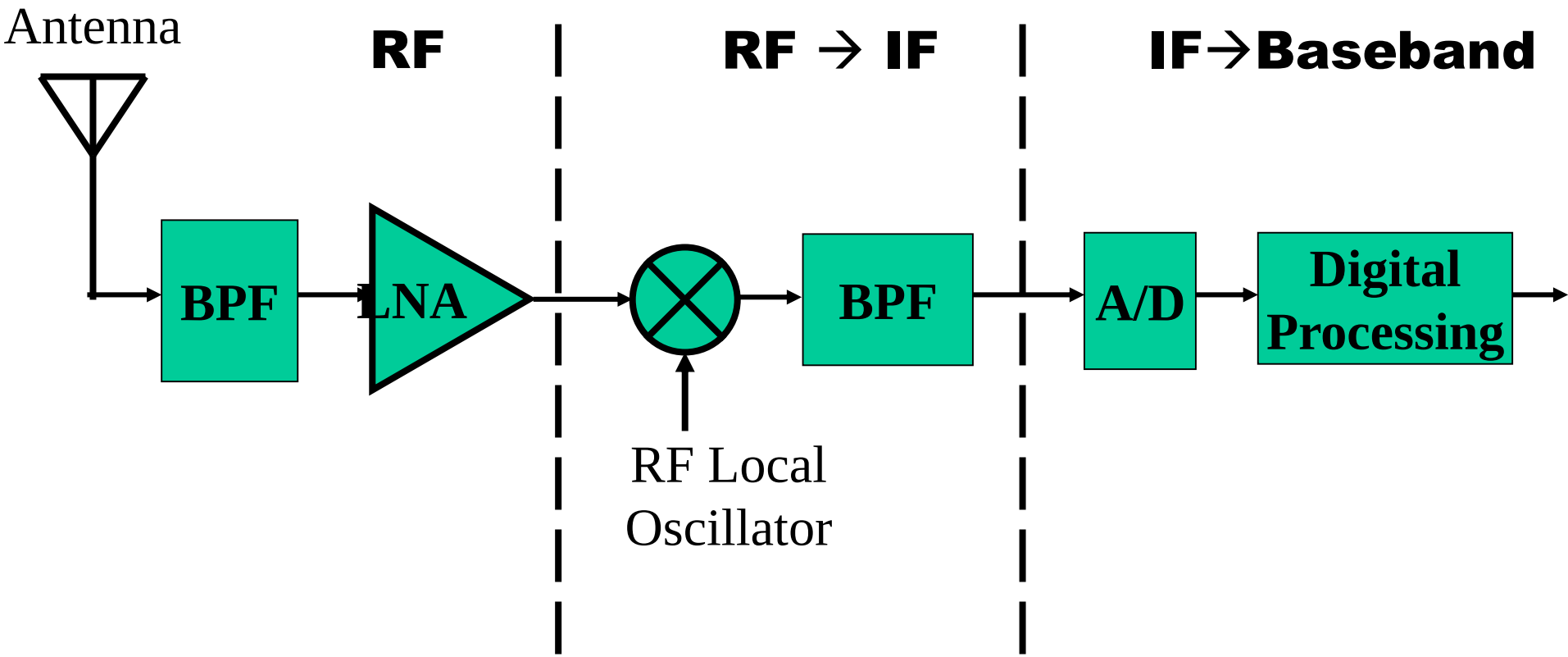


Step 2:

- RF/IF sections are realized with analog circuits
- Process channel and source coding by DSPs or FPGAs
- Baseband modem is also realized by DSPs or FPGAs

Step 3:

- Process RF/IF signals with DSPs or FPGAs
- Process channel and source coding by DSPs or FPGAs
- Baseband modem is also realized by DSPs or FPGAs

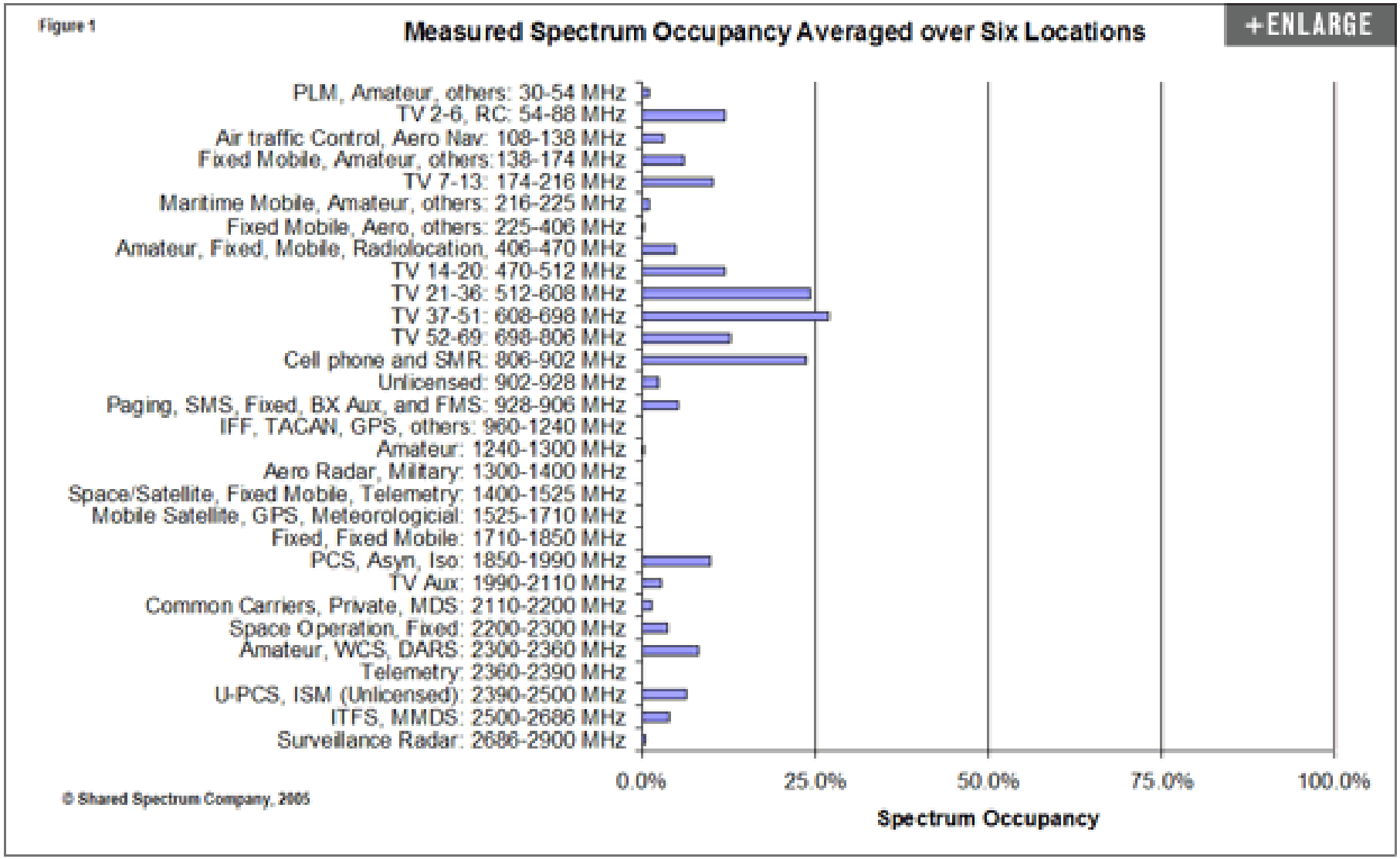


四、认知无线电（Cognitive Radio）

- Existing spectrum policy forces spectrum to behave like a fragmented disk
- Bandwidth is expensive and good frequencies are taken

- Measurements by the FCC show 70% of 0-2.5 GHz spectrum is not utilized
- Spectrum occupancy varies with location and time
- Idea: Opportunistically use unused spectrum with cognitive radios

- Spectrum usage measurements averaged over six locations [SSC]
  - average occupancy over all of the locations: 5.2%; Jan.' 04-Aug.' 05



- **Mitola - Cognitive radio signifies a radio that employs model based reasoning to achieve a specified level of competence in radio related domains.**

- **FCC - A cognitive radio (CR) is a radio that can change its transmitter parameters based on interaction with the environment in which it operates.**

- **Kolodzy - A cognitive radio has the flexibility and the adaptability to change its operating conditions to its environment (either real or perceived)**

- **Early SDRF Draft - The term Cognitive Radio refers to a radio that has, in some sense, (1) awareness of changes in its environment and (2) in response to these changes adapts its operating characteristics in some way to improve its performance or to minimize a loss in performance.**

认知无线电网络能通过主动地感知无线频谱使用、认知无线环境、自适应地重配置网络资源、工作模式与参数，进而实现与周边无线网络协同工作的目标。

(1)无线频谱环境认知理论与技术

(2)基于认知的无线资源动态管理与利用

(3)基于认知无线电的通信抗干扰理论与技术

(4)可以重新配置平台