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# *SDR Implementation Issues: RF Front End Nonlinearity and Dynamic Computing resource allocation*

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# *Outline*

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- **Introduction**
- **RF Front End Nonlinearity**
- **Dynamic Computing resource allocation**
- **Conclusions**

# ***SDR is Good***

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- **Multi-band multi-mode reconfigurability gives a lot of flexibility and other benefits for telecommunication system design and development**
- **But, challenges do exist, particularly for low-cost SDR**

## ***Our Contributions***

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- **Address two practical issues governing SDR performance that are often overlooked: RF front end nonlinearity and dynamic computing resource allocation**
- **Two widely known problems, but mostly separately in two different areas. Quantitatively demonstrating both helps SDR users in their developments**

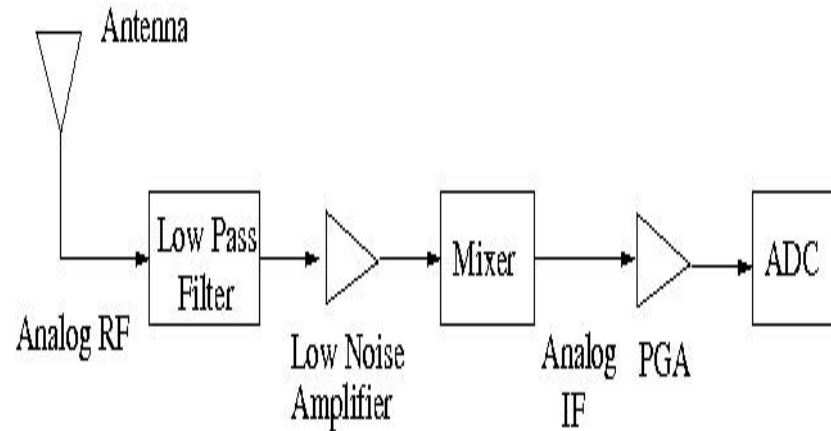
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# *One RF Front End Example*

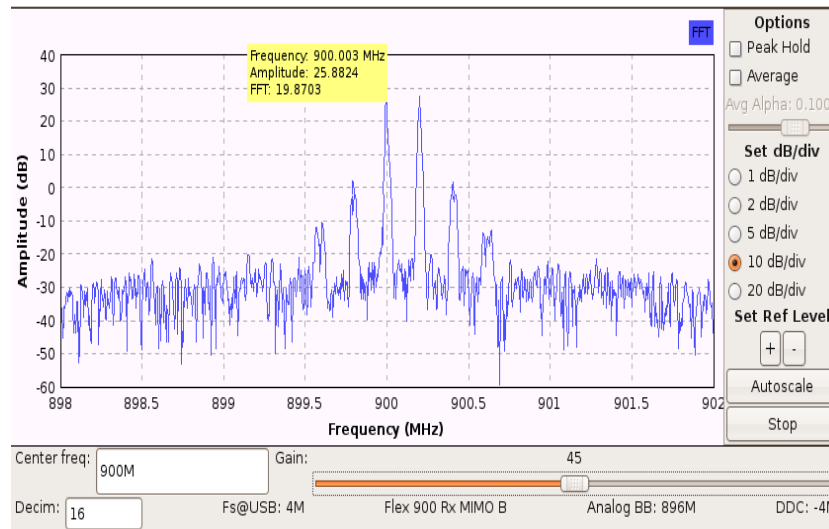
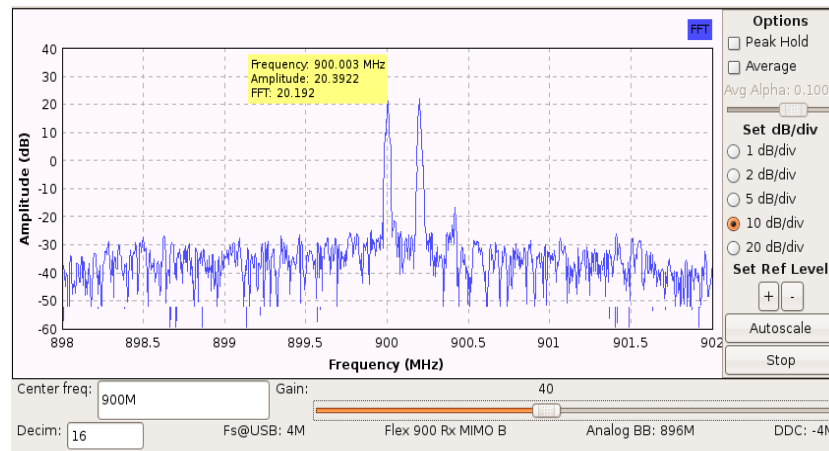
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**The RF front end in the USRP**

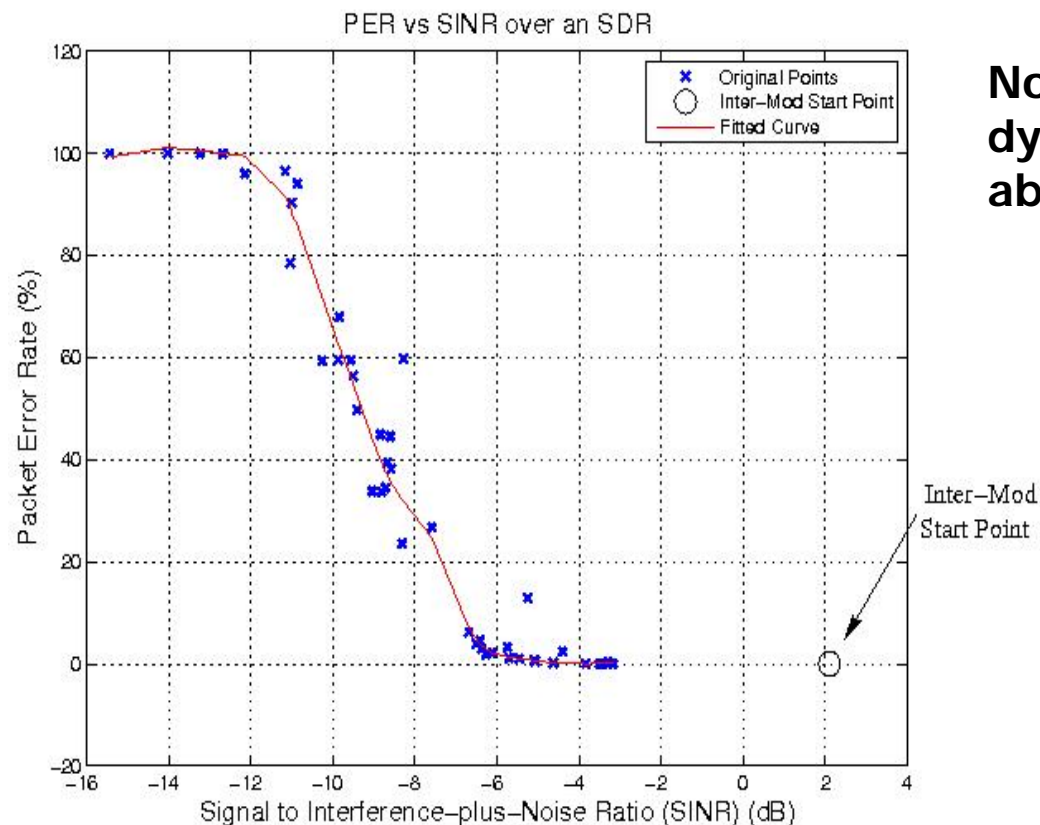
**What is the nonlinearity characteristics of this whole system?**

# One Example



# *PER vs. SINR Distribution*

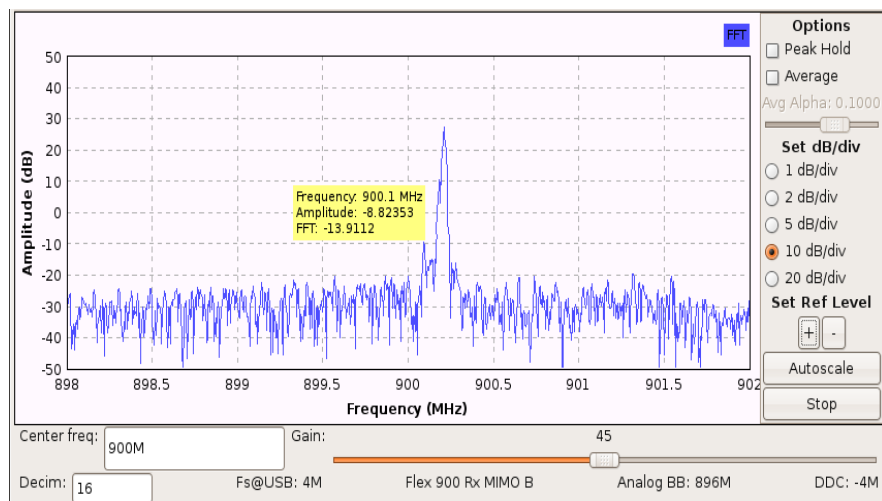
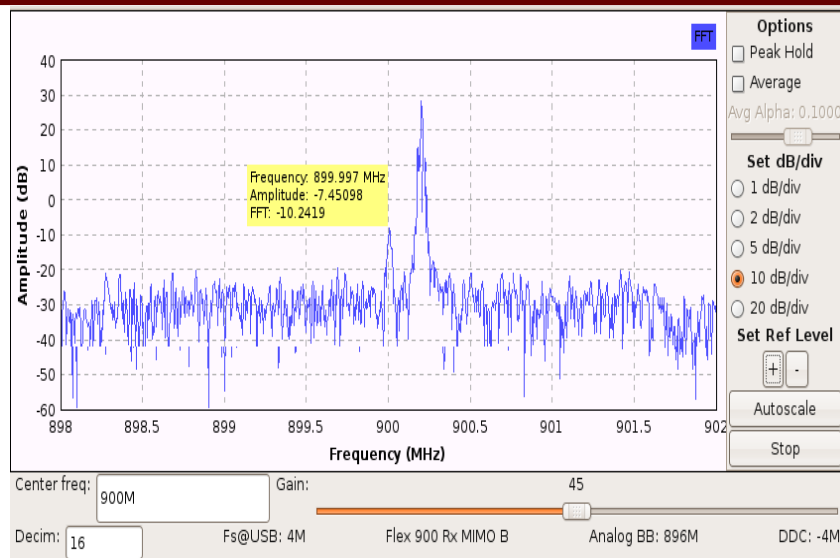
Instead of varying RX gain, we changed the TX's power in a big range. Then we calculated the final received SINR and packet error rate (PER)



Notice that the effective dynamic range is only about 7 dB



# Adjacent Channel Interference



# *RF Front End*

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- RF front end non-linearity is a challenging problem in SDR
  - applicable to a variety of signals with widely differing center frequencies, modulation bandwidths, and power levels
  - Filtering signals is demanding

# *Outline*

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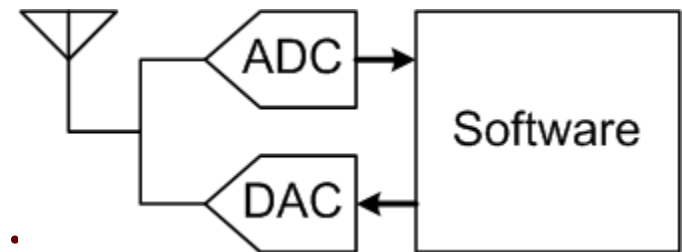
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# *Real-time Performance Required in SDR*

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- What does it mean for the digital domain when SDR moves radio functions to the software domain? Radio problems become computing problems

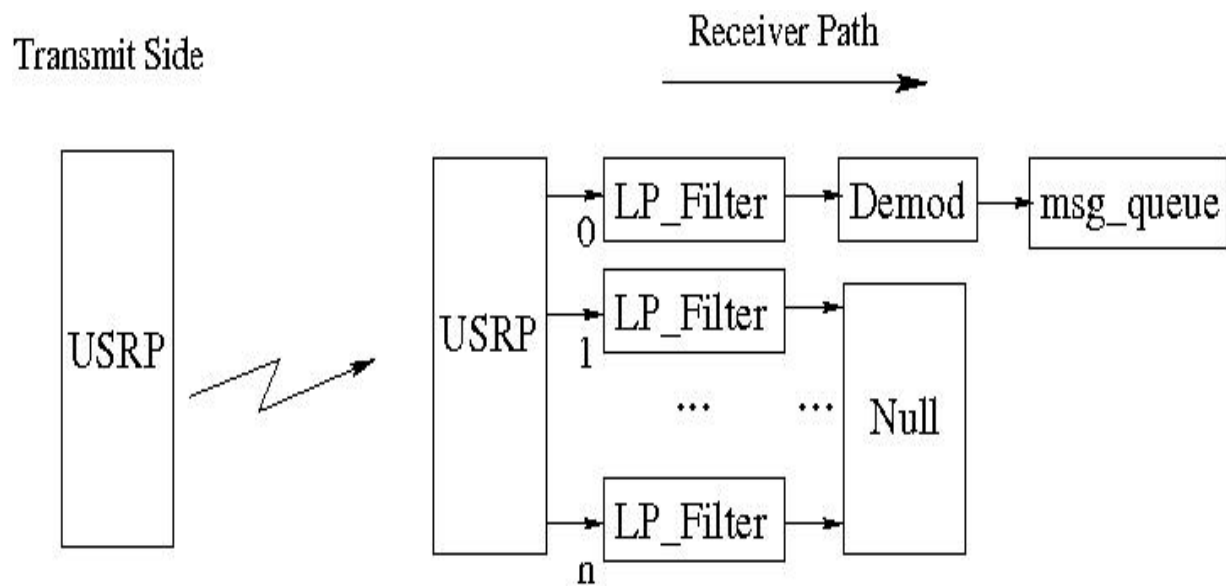
- Power, size
- Software, usability, security, ..



- Here we consider the performance requirement
  - Fundamentally digital communication requires a real-time performance, A great challenge!
  - Performance of both embedded system and general purpose computers

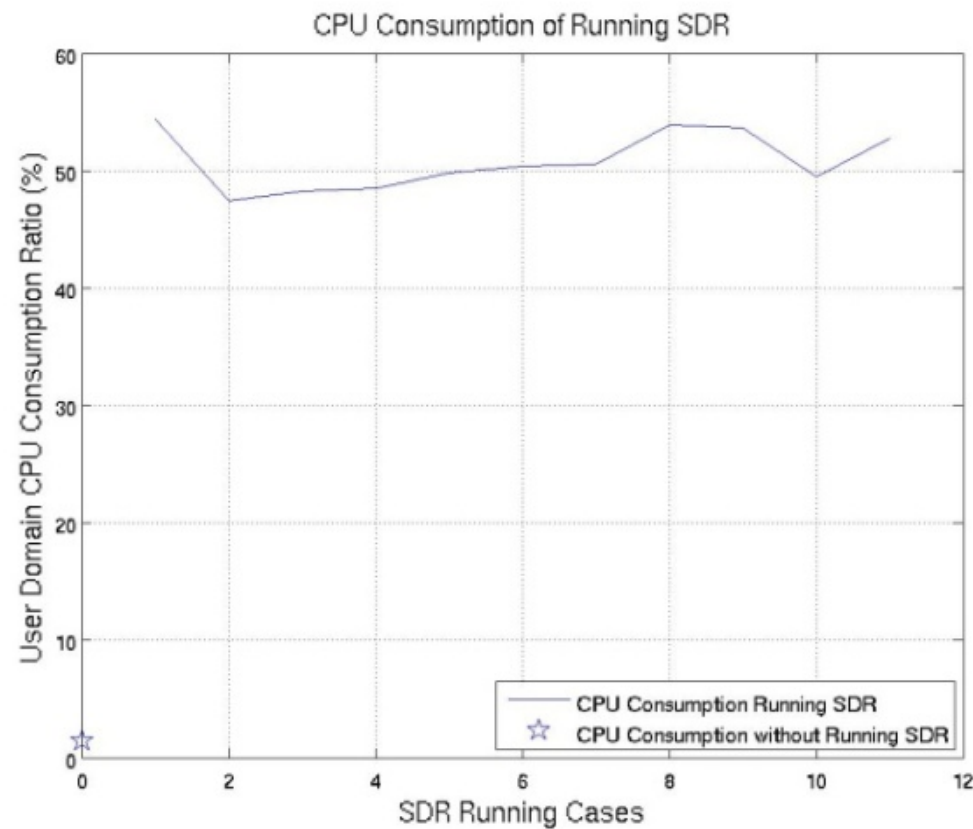
# How to Analyze?

A wireless link built from GNU Radio and two USRPs



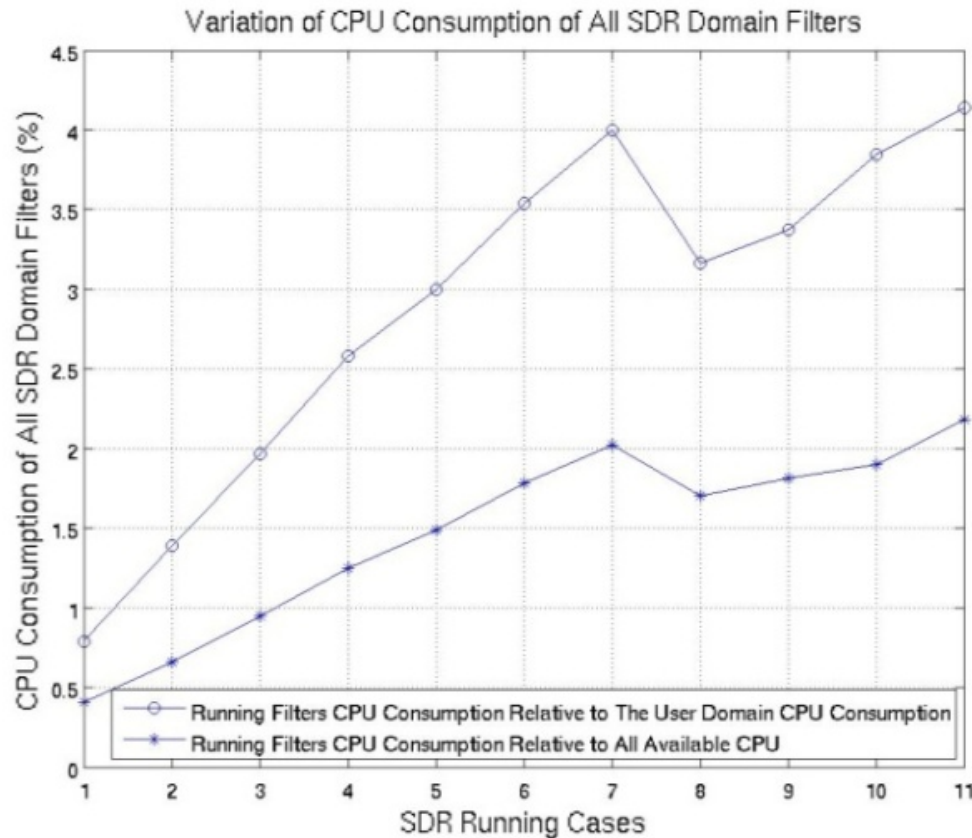
As we increase the amount of computing requirement, how will the performance vary?

# Overall CPU Consumption



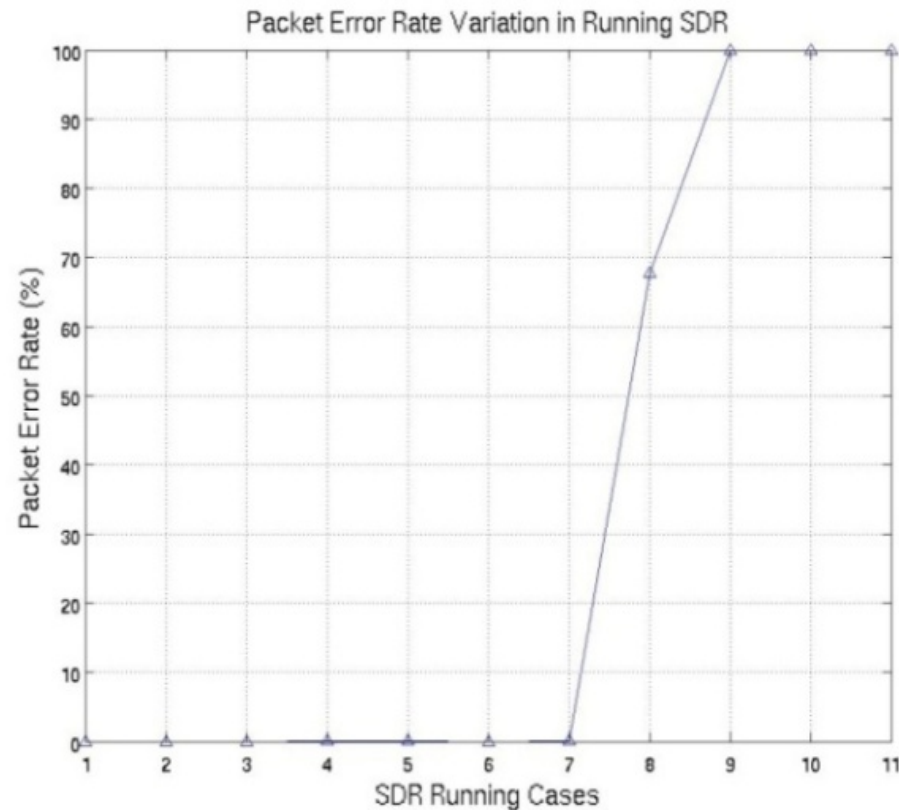
The overall CPU consumption varies little.

# *The CPU Consumption Increase with Extra Computing Tasks*



The CPU increase for each extra filter is about 0.5% of the overall CPU resource

# *The Performance Variation*



**At a threshold value, a small amount of required CPU increment may result that an SDR receiver performance deteriorates abruptly**



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# *Conclusions*

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- **Demonstrate RF front end nonlinearity and dynamic computing resource allocation challenges widely faced by SDR users**
- **Future: how to solve the above two problems?**

# Acknowledgement



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## National Science Foundation

WHERE DISCOVERIES BEGIN

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# Questions?

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