



Isfahan university of technology

# **INTRODUCTION TO CHANNELIZATION ALGORITHMS IN SDR AND COMPARISON OF THEM**

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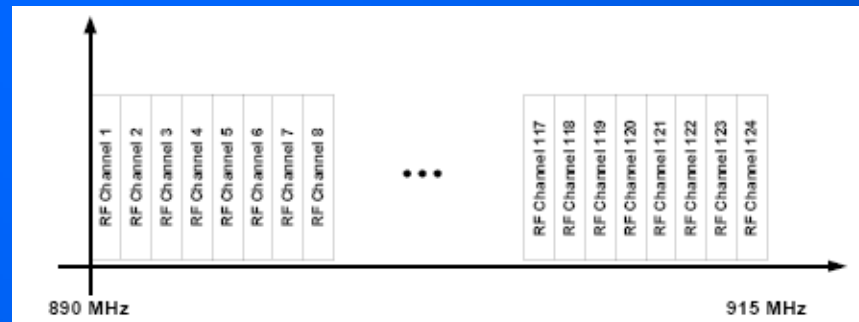
1386-1387 Spring

- the ideal Software Defined Radio (SDR) is all signal processing is done in software ,therefore we can support multiple communications channels
- A wideband transiver has to simultaneously deal with hundreds to few thousands channels
- One of the most computation intensive tasks in such receiver or transmitter is channelization

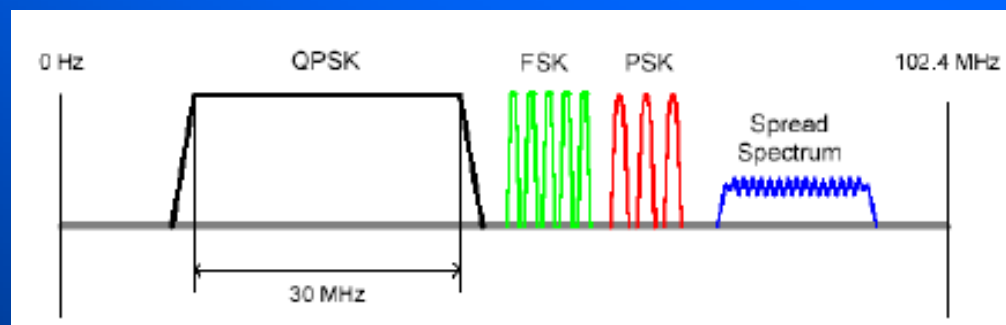
- subjects forcing the channelization architecture :

## 1-Spectral Content of the Wideband Channel

- the system architecture typically defines a fixed carrier spacing with a constant RF bandwidth per carrier channel . such as cellular phone



- both the carrier frequency and RF bandwidth per carrier are dynamically assigned. This type of architecture is found in a multi-standard communications system such as a multi-standard satellite gateway



## 2- Processor Selection for Channelization Processing:

general purpose processors allows for maximum reuse of application code across multiple platforms and maximizing the return on investment in application software through code reuse and up grad ability but:

- The power utilization and heat dissipation of GPPs are often preventing in many size, weight, and power limited systems. As a result, Digital Signal Processors (DSPs) are often utilized to supplement the processing provided by the GPP to keep the architecture within the specified power budget.
- GPPs and DSPs employ a serial processing architecture that does not provide sufficient performance for the processing of wideband signals. As such, the use of FPGAs, is often required in the SDR platform.

Front-end channelization processing limited to FPGAs due to performance constraints in dealing with the wideband input, although back-end processing which is preformed on a per channel basis may incorporate DSPs or GPPs.

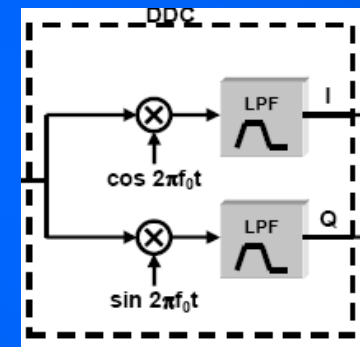
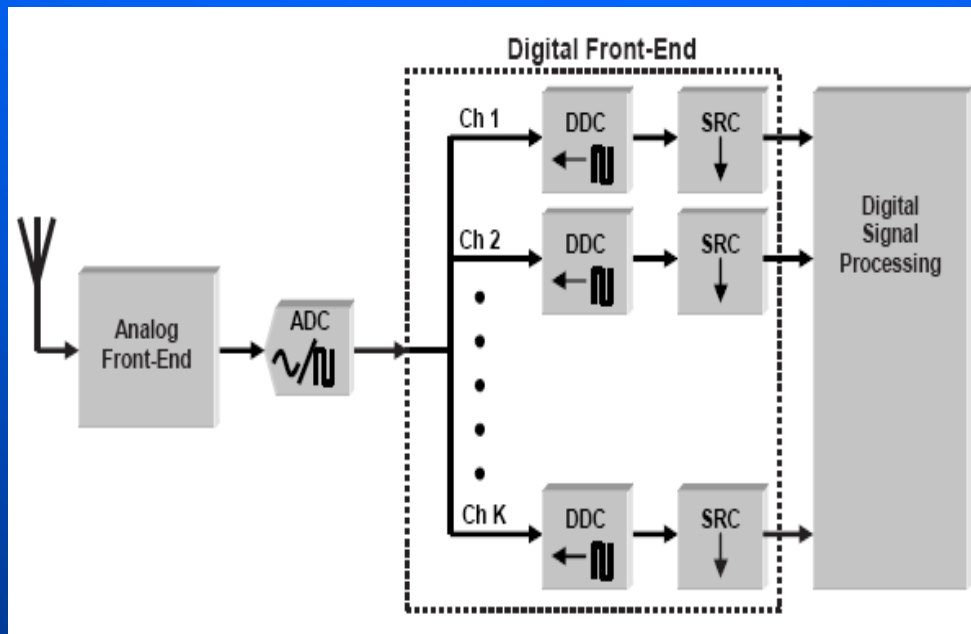
**channelization** is a process where single, few, or all channels from a certain frequency band are separated for further processing. The separation of single channel is usually done by down-conversion followed by filtering and optional sample-rate conversion.

## **Channelization Algorithms :**

- 1. The per-channel Approach.**
- 2. Pipelined Frequency Transform.**
- 3. Polyphase FFT .**

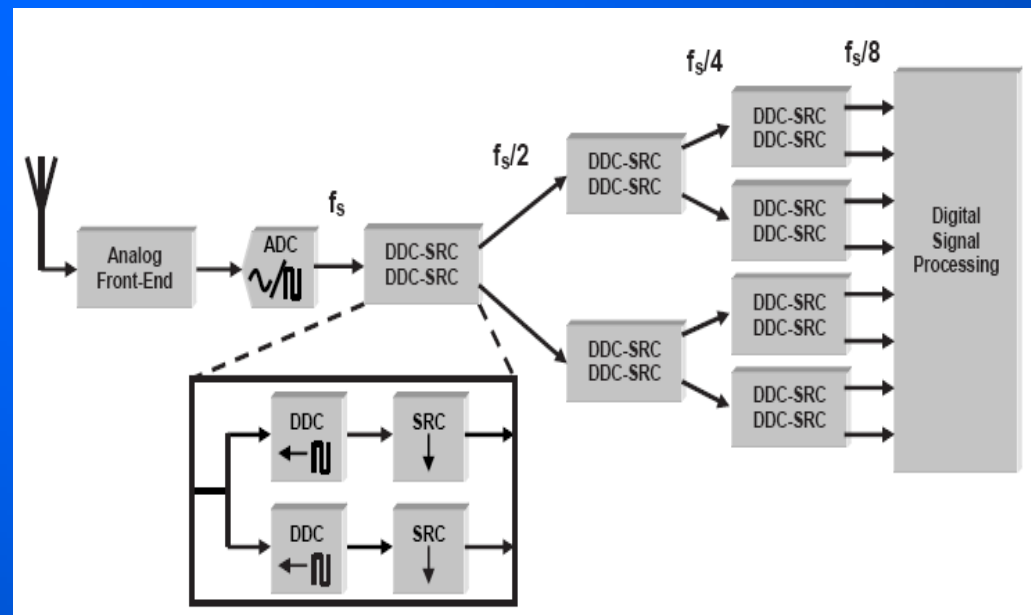
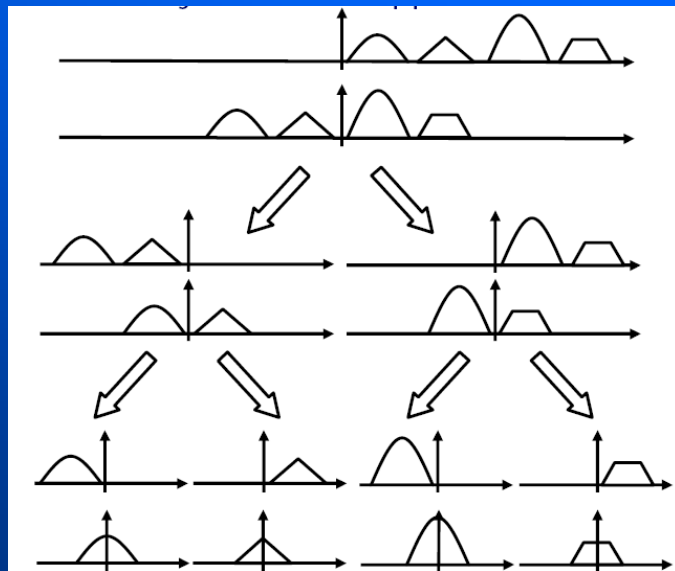
# 1. The per-channel Approach:

A simple implementation, is use a single-channel channelizer for each channel of interest, and connect them all to the input frequency band signal .



## 2. Pipelined Frequency Transform:

The Pipelined Frequency Transform (PFT) algorithm is based on a binary tree of DDCs and SRCs.



This algorithm for itself has no advantage over the algorithm presented in the previous section and is actually much more expensive in terms of silicon use, since apart of a single-channel channelizer for each channel of interest in the last stage of the tree, many more are needed in the other stages.

Advantage:

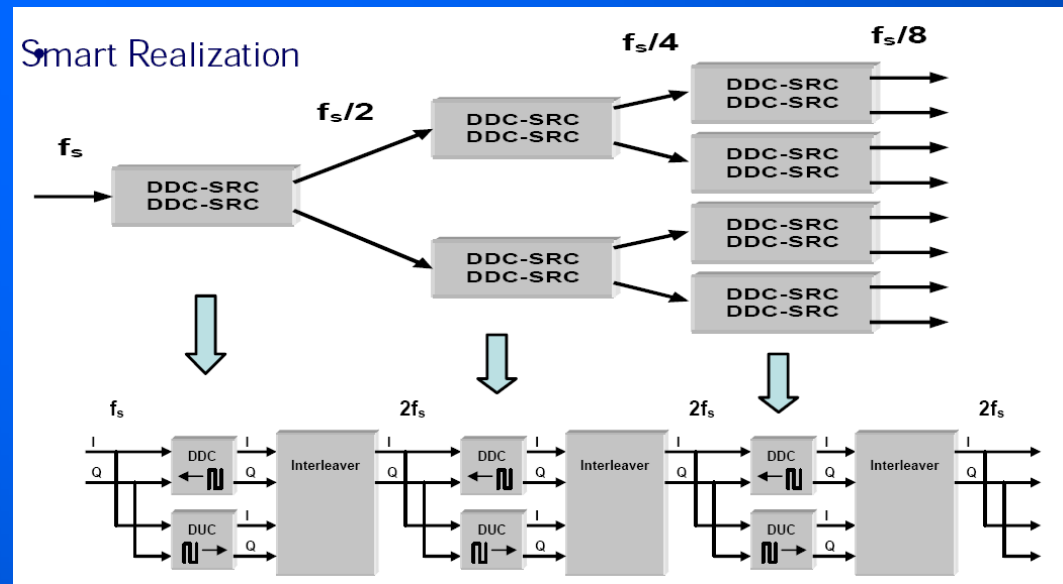
**Smart realization.**

**Half band filters.**

**Half of the sampling rate.**

**Intermediate output.**

**Same action in each step**

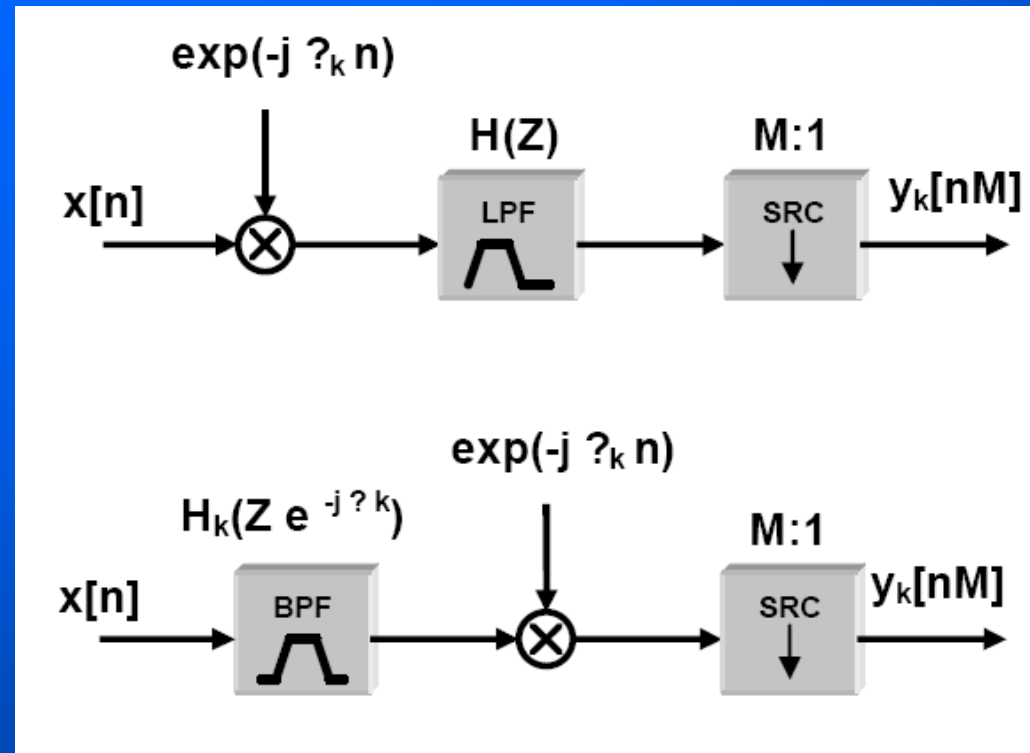


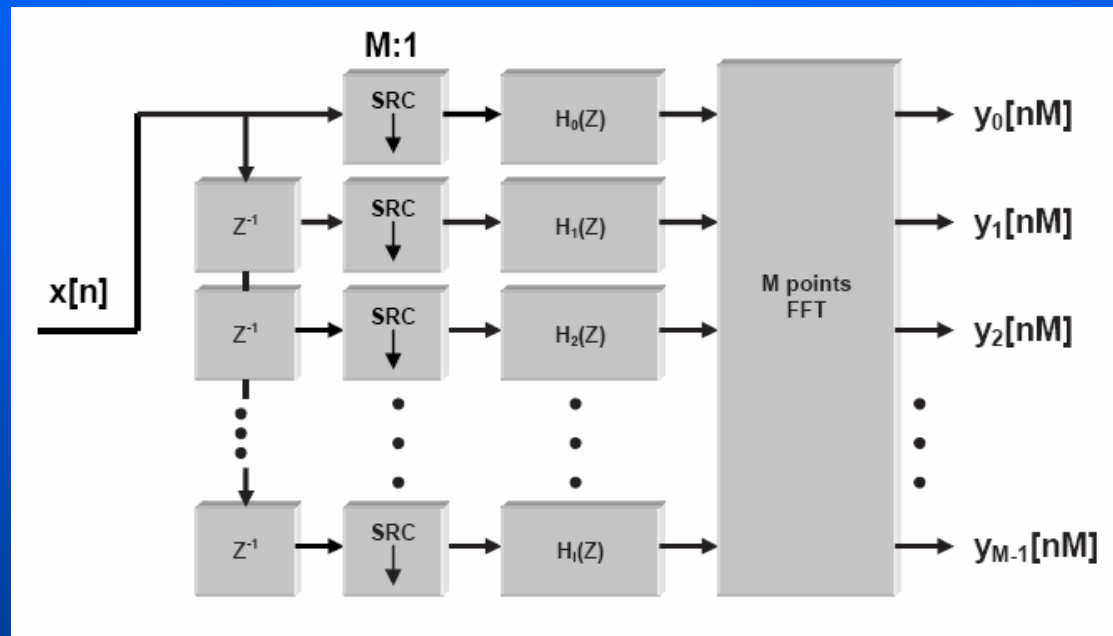
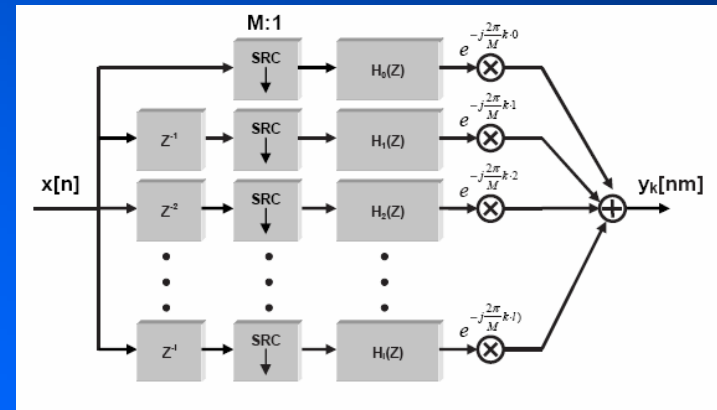
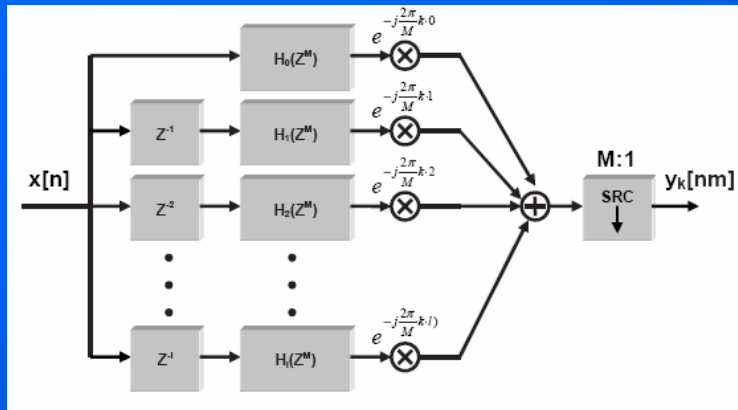


### 3. Polyphase FFT :

This channelization algorithm is an improvement of FFT channelization using a polyphase filterbank in combination with FFT

DDC+LPF = BPF +DDC



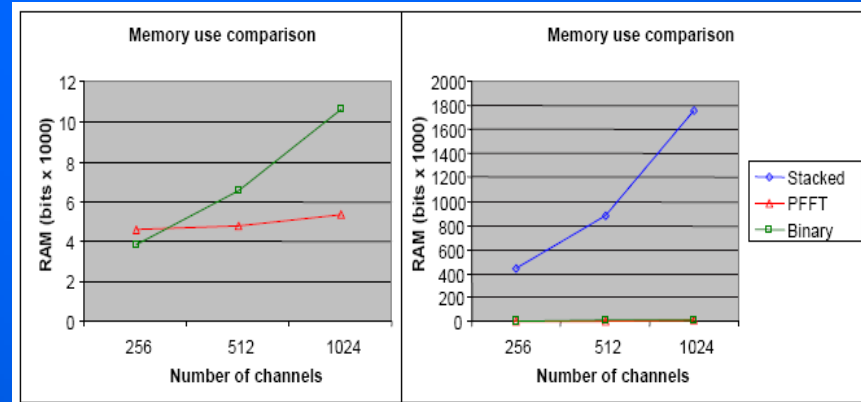
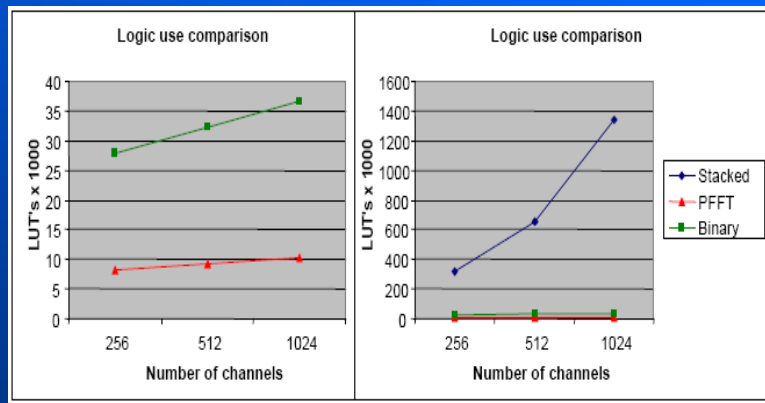


# Algorithms Comparison:

## 1. Hardware Complexity Comparison:

The first comparison is for LUT (logic use comparison on FPGAs basic block) utilization

The second comparison is of memory bits utilization.



## 2. Qualitative Comparison :

### Computational complexity :

which is usually derived from simulations and software implementations.

### Silicon cost(size)

Comparison is based on actual implementation in FPGA

### Group delay

### Flexibility :

- 1.Initial design
- 2.Reconfiguration

Aspect		Algorithm		
		Per-Channel	PFT	PFFT
Computational Complexity for high number of channels		Poor	Good	Excellent
Silicon Cost Efficiency		up to 3-20 channels	up to 128-256 channels	8-16 channels and above
Group Delay		Good	Good	Good
Initial Design Flexibility	Independent channels	Yes	No	No
	Number of channels	Selectable	$2^{INT}$	Preferably $2^{INT}$
	Intermediate outputs	No	Yes	No
Flexibility for Reconfiguration	Addition / removal of channels	Excellent	Poor	Poor
	Filtering independence	Poor	Poor	Good

# Conclusion :

we introduced three different channelization algorithms. Namely, the per-channel, the PFT, and the PFFT algorithms, explaining in details. then we compare them.

based on HW comparison == >PFFT algorithm is better.

Based on qualitative comparison == > per-channel algorithm is better.

So the designers must trade off .....

Thank you for attention

Any question?