Flexible Modulation Format For Future Optical Network

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Research Motivation

•My work is aiming at these two parts of network, which is long haul and large capacity network.

•The goal is to increase the capacity for a given distance in a fixed grid according to the traffic demand.

Submarine Network

Central Office (CO)

Metropolitan Local-exchange Network

Long Haul Interexchange Network, or"Core Network" (national and international)
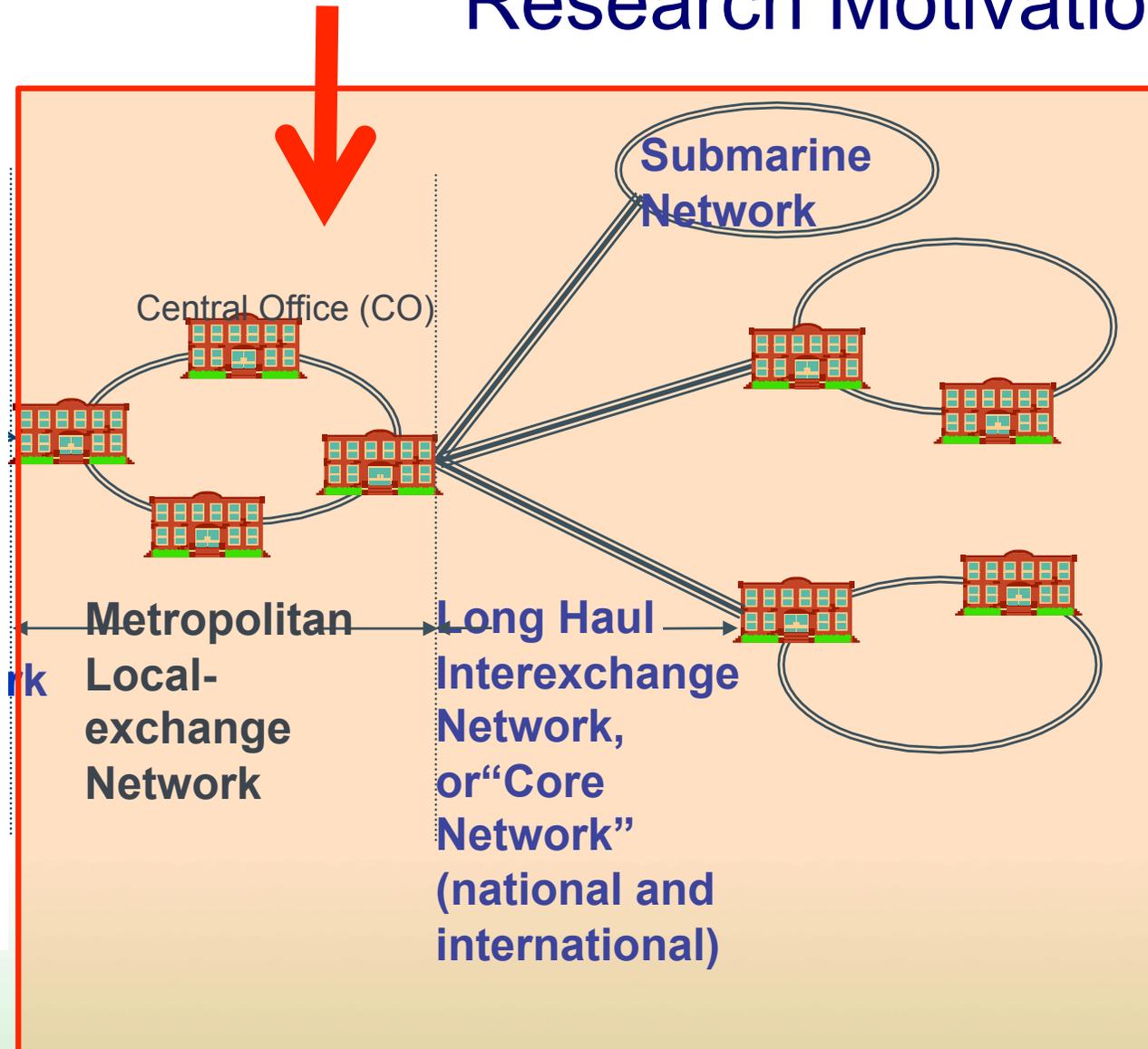
- How to increase the capacity per fiber?

1. Better device. (e.g. DAC, fiber, DSP)

2. More channels per fiber.(Total bandwidth in C band about 4 THz)

3. Higher spectral efficiency (complex modulation format in physical level)

- Different method compare.

Approach 3 advantage: less investment, work under nowadays ITU grid, work with the existed equipment.
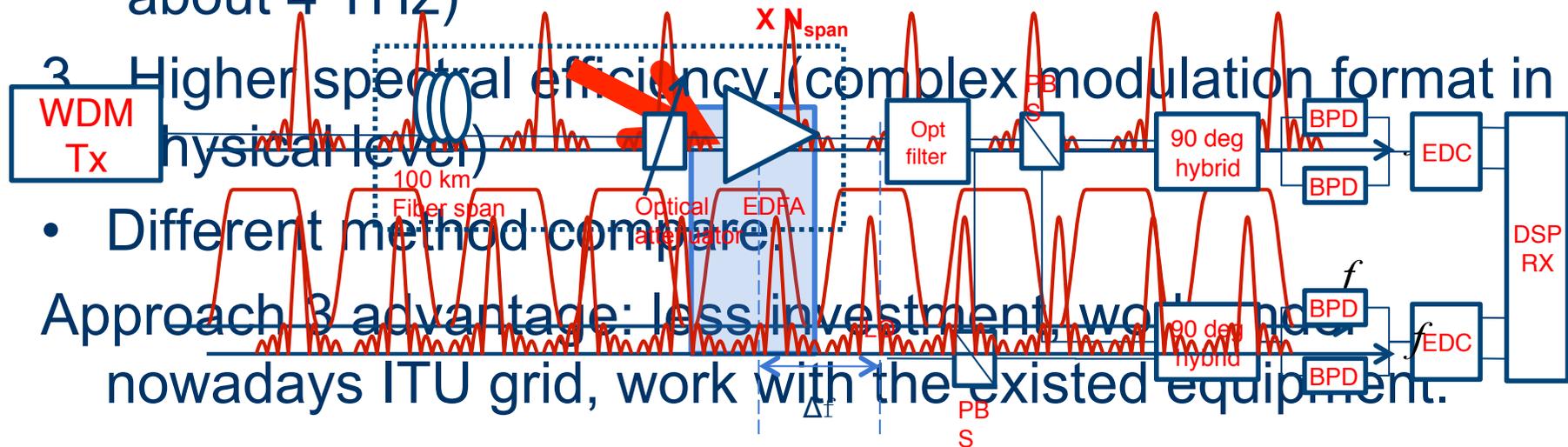
- Standard multilevel modulation format optical transmission system "Max distance vs. Capacity", but with a flexible grid.

- Gap between different curves and markers.

- Finding a new modulation format that has the largest capacity at a given distance in a fixed grid according to the traffic demand..
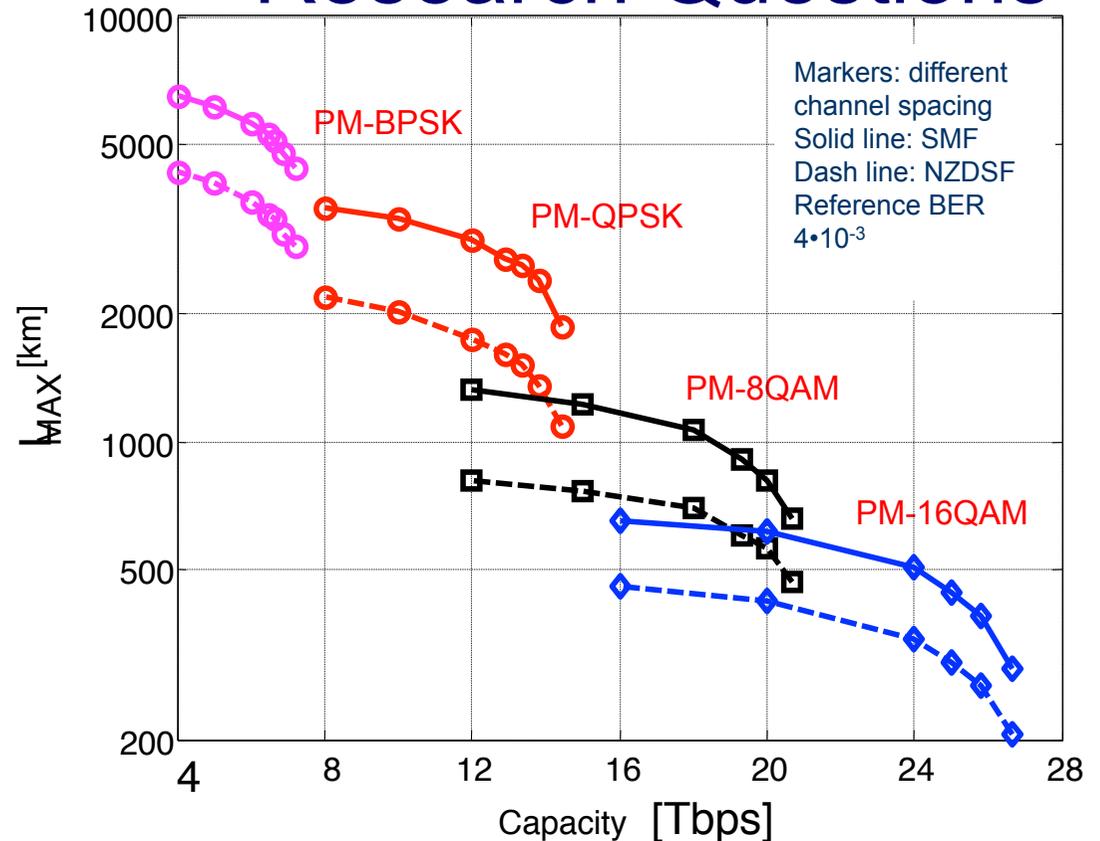
On the Performance of Nyquist-WDM Terabit Superchannels Based on PM-BPSK, PM-QPSK, PM-8QAM or PM-16QAM Subcarriers *Bosco,G et al. Lightwave Technology, Volume: 28, Page: 53-61*

Frame : $M = M_1 + M_2$ [symbols]

M_1 symbols

SSMF

M_2 symbols

Modulation Format F_1:
P_1, SNR_1, BpS_1

Modulation Format F_2:

Format ratio : $FR = 100 \dfrac{M_2}{M}$ Power ratio : $PR = \dfrac{P_2}{P_1}$

$$P_{Tx} = \left(1 - \frac{FR}{100}\right) \cdot P_1 + \frac{FR}{100} \cdot P_2$$

$$SNR = \left(1 - \frac{FR}{100}\right) SNR_1 + \frac{FR}{100} \cdot SNR_2$$

-symbol: $BpS = \left(1 - \frac{FR}{100}\right) BpS_1 + \frac{FR}{100} \cdot BpS_2$

ctralefficiency: $SE = BpS \dfrac{\Delta f}{R_s}$

maximize the ... ven distance.
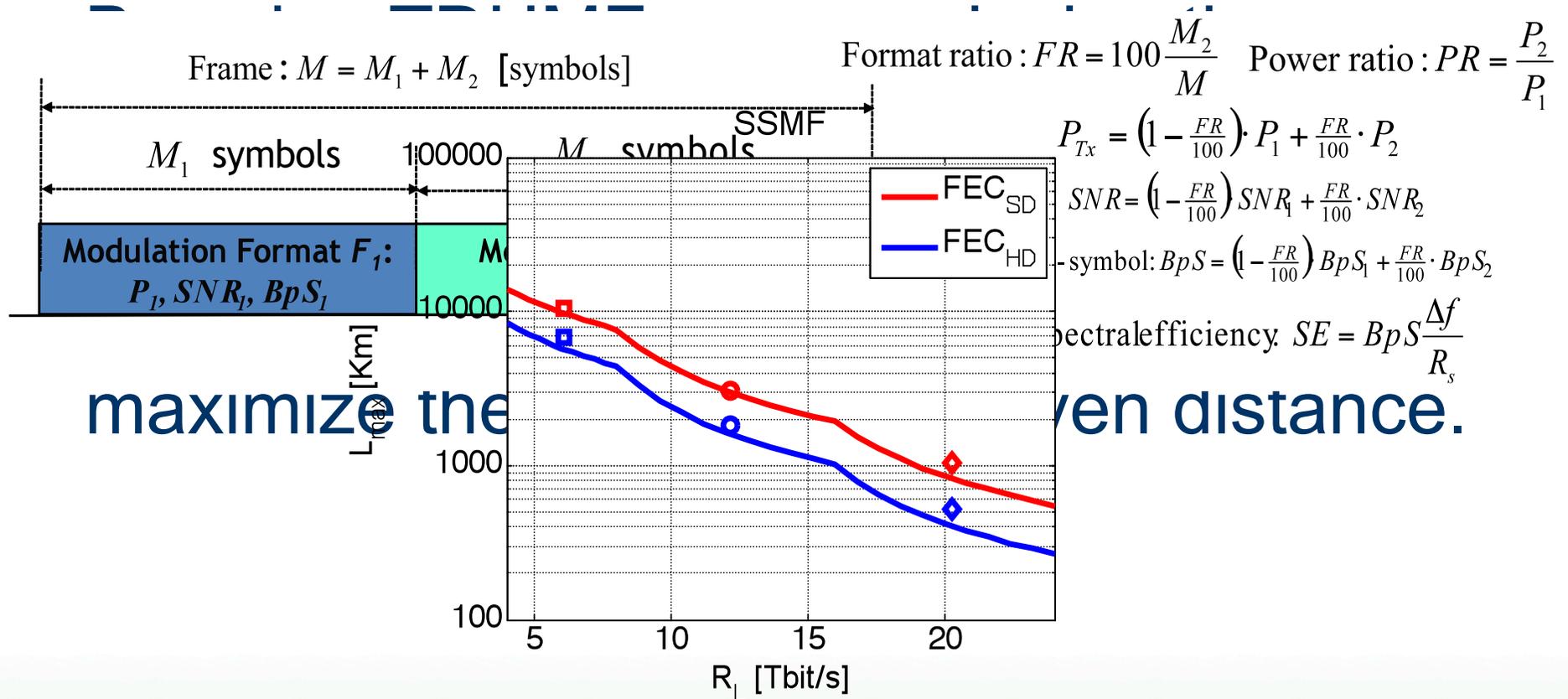
Back-to-back and Nonlinear Propagation Perfomances of FlexQAM modulation(paper under submission,), Squared markers: HEXA, circular markers: PM-8QAM, diamond markers: PM-32QAM.

L_{max} [Km]

R_L [Tbit/s]

FEC$_{SD}$

FEC$_{HD}$

Flexible M-PAM Modulation Format (Flex-PAM)
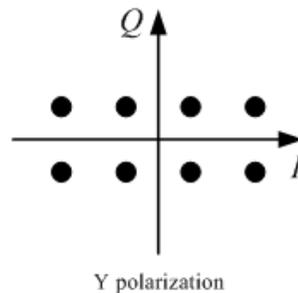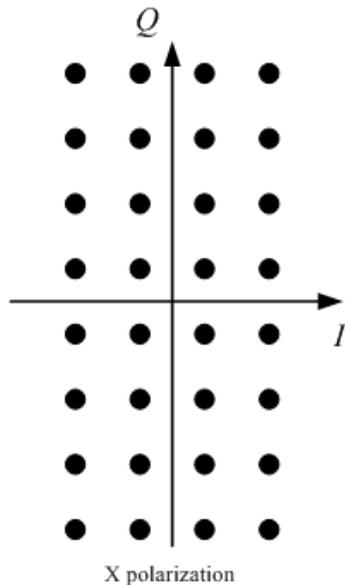
$$BER = \frac{1}{BpS_{tot}} \cdot \sum_{i=1}^{4} \frac{m_i - 1}{m_i} \cdot erfc\left(\sqrt{\frac{3}{m_i^2 - 1} \cdot 2 \cdot \frac{P_i}{P_{tot}} \cdot SNR}\right)$$
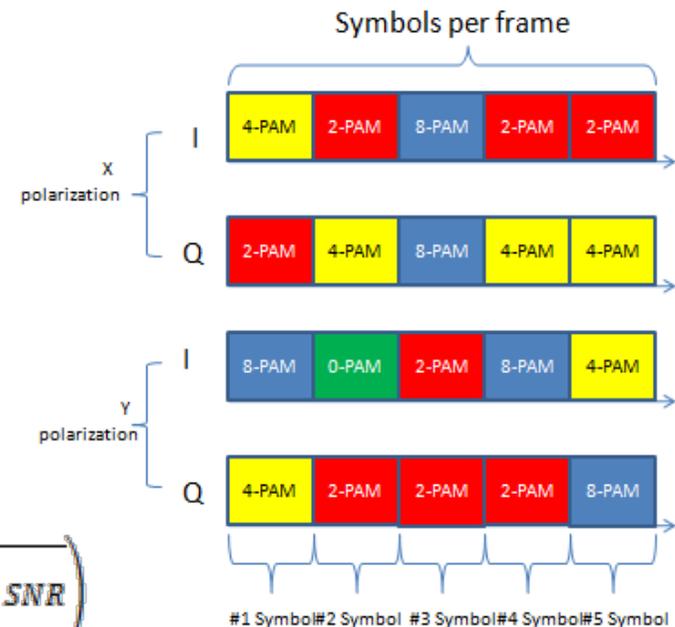
1. Unlike TDHMF, Flex-PAM offers limited possibility of system capacity. But it will have advantage in optical network level.
2. For different network tributary, we can arrange one m-PAM for it according to traffic demands.
3. It has a much simpler Tx/Rx and DSP structure against TDHMF.

Flexible M-PAM Modulation Format (Flex-PAM)

- Back-to-back simulation results show no penalty against theory.

- I am still working on the propagation simulation.
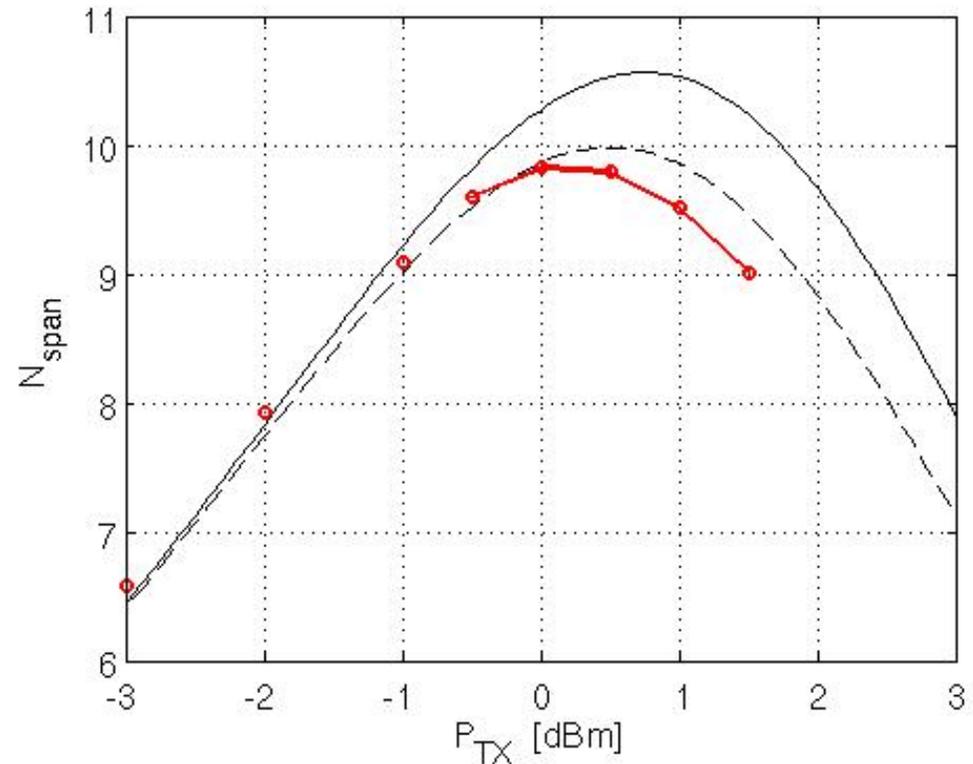
Mixing Modulation Format on Different Channel

- Using different modulation format on different channel

- A simplified three channel model is build.
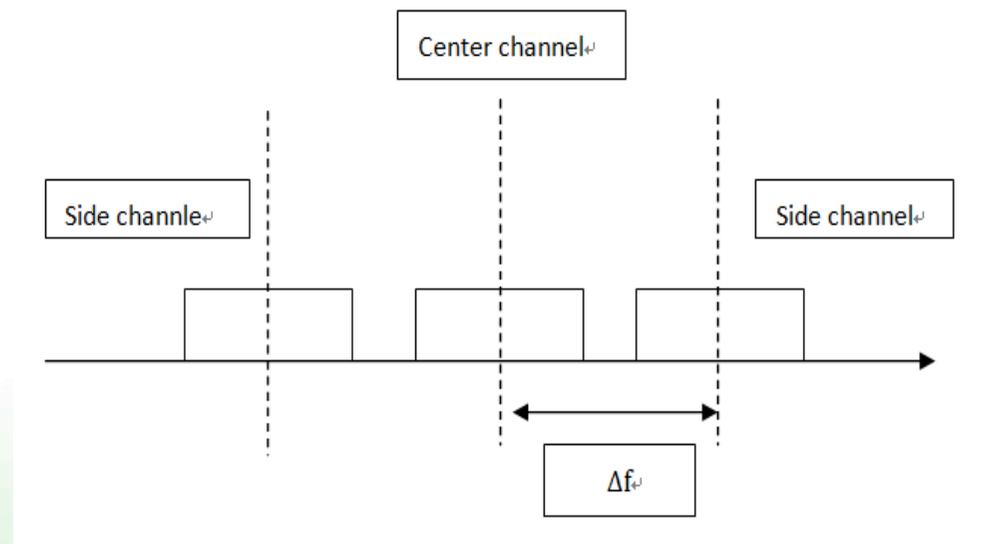
Mixing Modulation Format on Different Channel

- In most of the situation, side channel won't make an huge impact on the center channel, but when side channel is BPSK, and the channel spacing is equal to the symbol rate, the center channel has advantage.

- I am working on the "BPSK effect".

fixed center channel BpS=4rolloff=0.2

Legend:
- ks=1p0
- ks=1p05
- ks=1p10
- ks=1p15
- ks=1p2
- singlech ref

X-axis: side channel BpS
Y-axis: Sensitivity(dB)
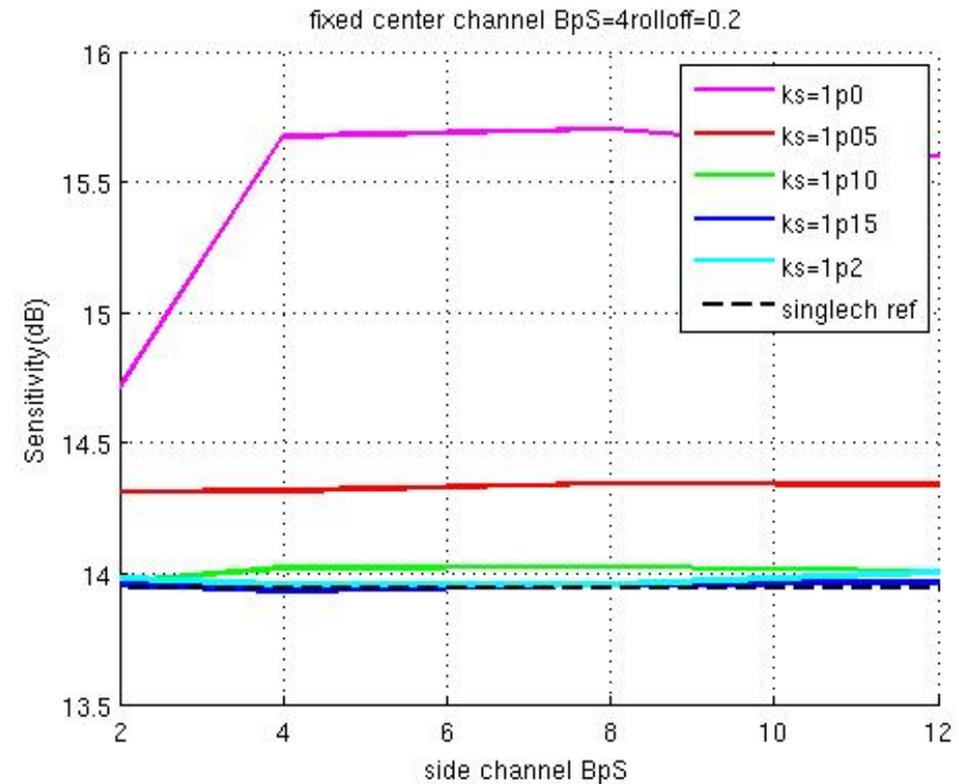
- Continue working on the transmission level, find the optimum solution.

- Work on the network level cooperate with other researchers.