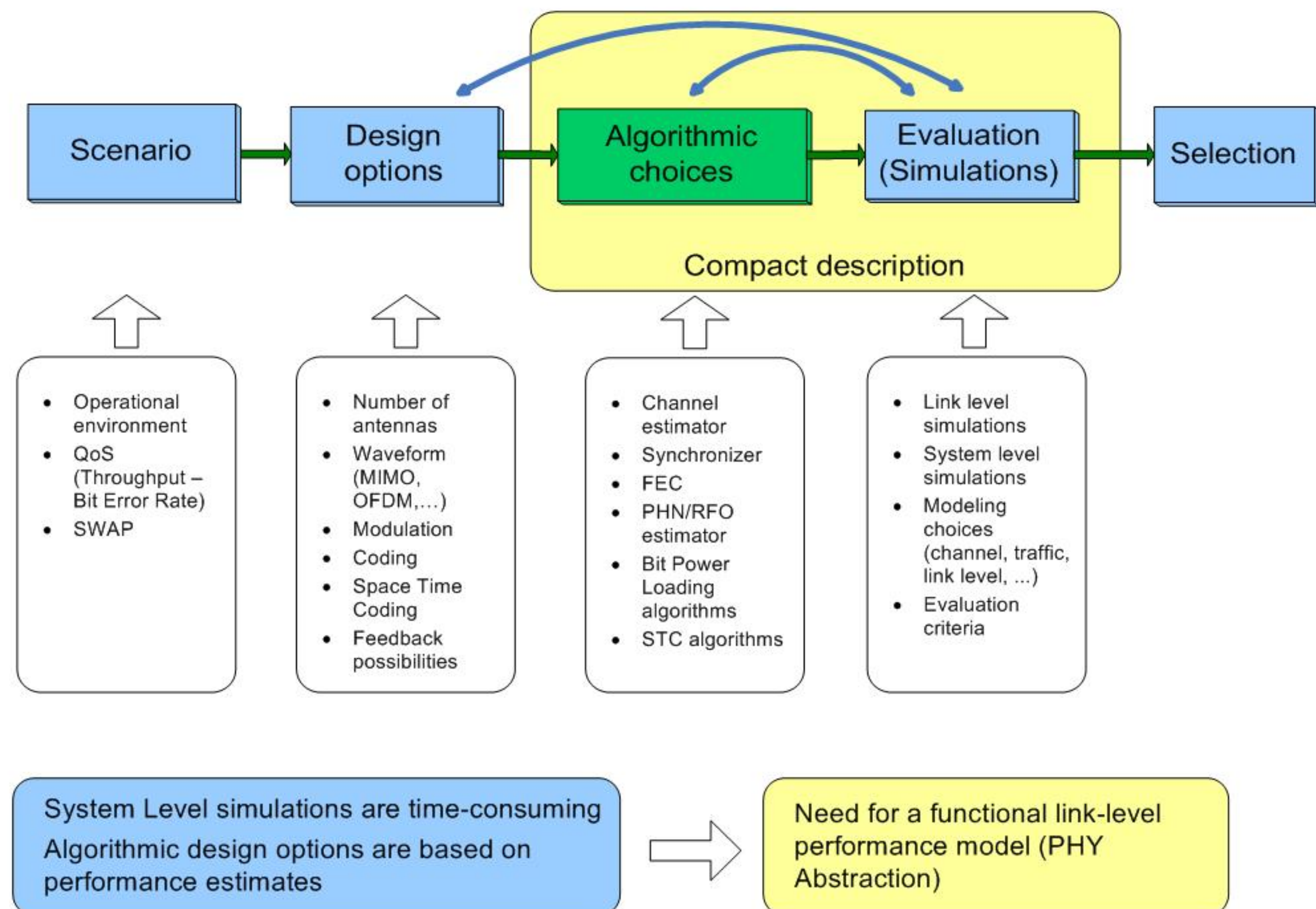


A general multi-carrier link performance modeling and design tool

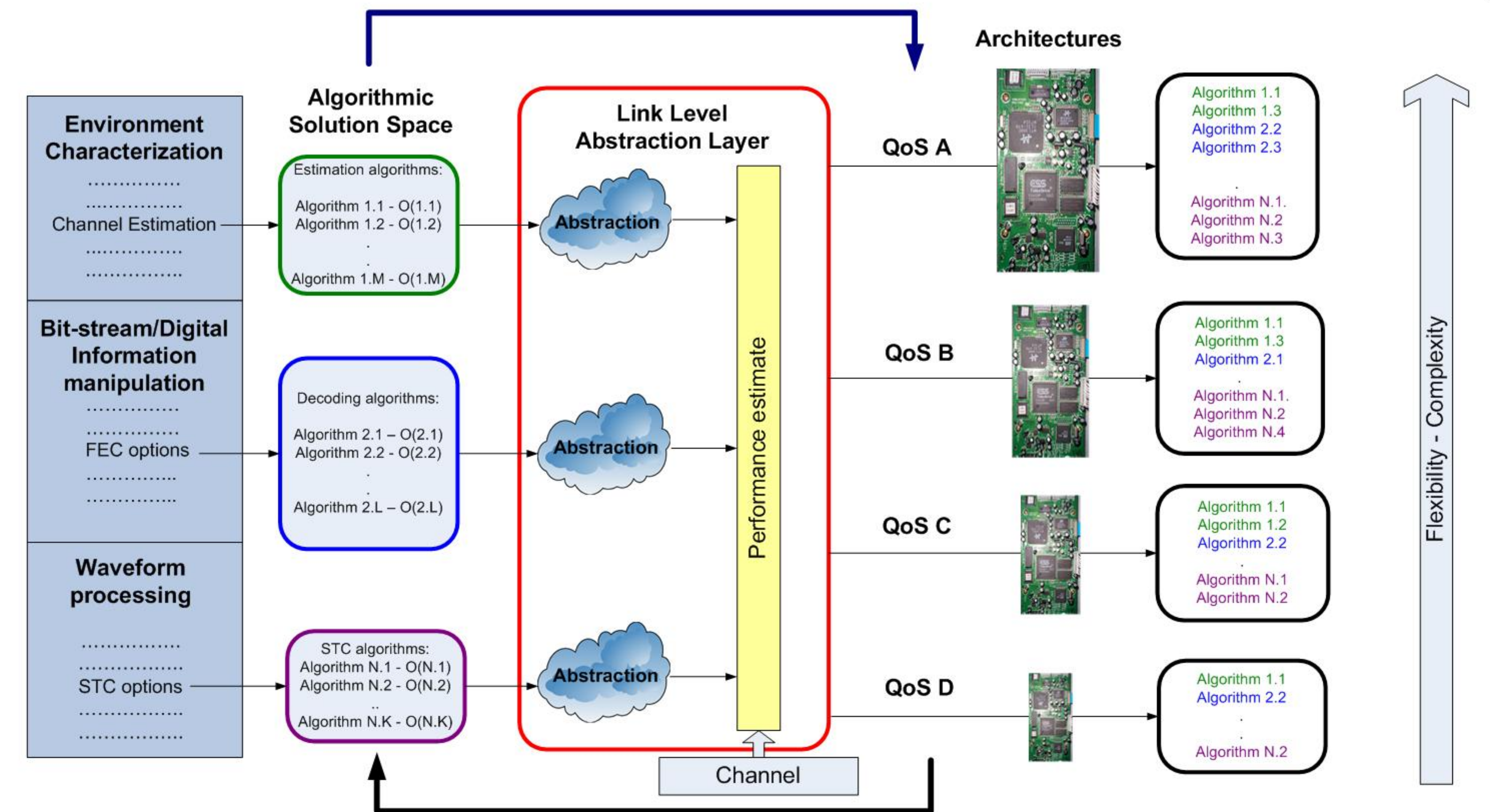
Andreas Polydoros, Andreas Zalonis, Ioannis Dages (NKUA/IASA), Adrian Kliks (PUT)

1. Generic system design procedure

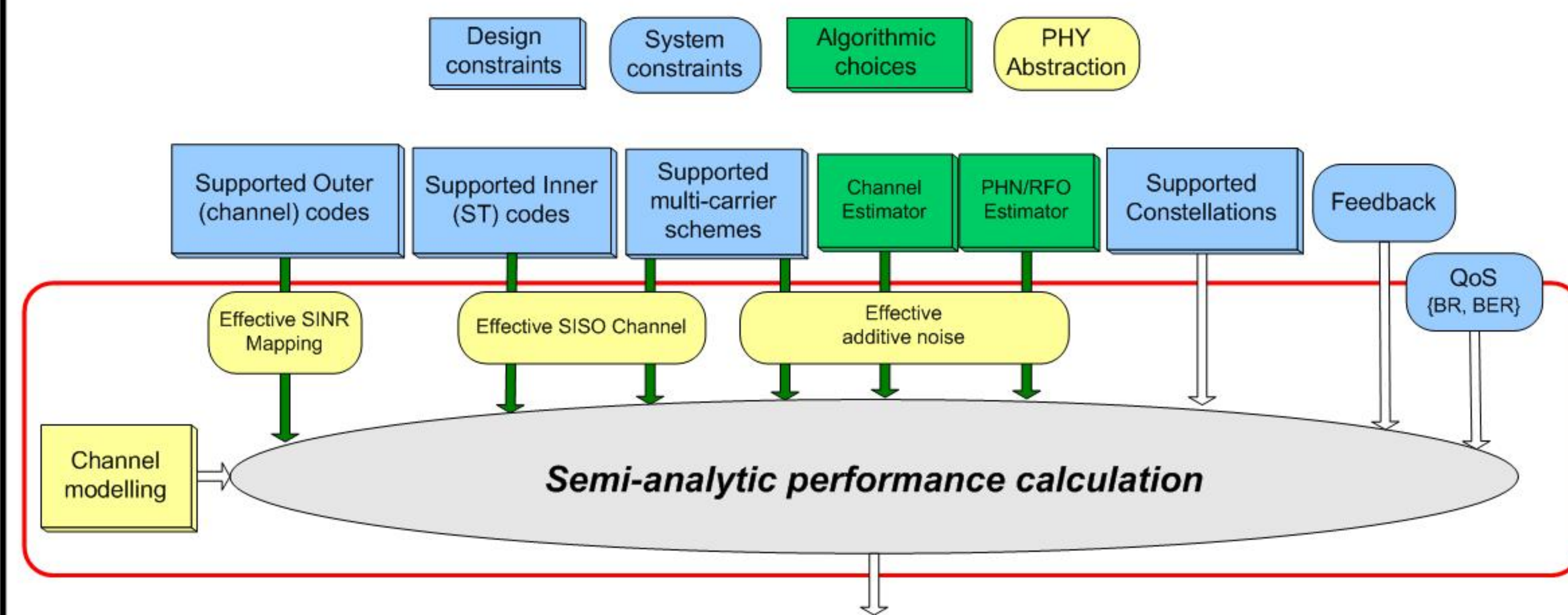


2. A generic design tool with Link level PHY Abstraction

- ✓ Evaluation of the performance of the various (design/algorithmic) choices can be time-consuming.
- ✓ Sometimes the algorithms include a performance prediction model (e.g. AMC).
- ✓ PHY Abstraction: accurate compact description modeling for link level performance prediction.
- ✓ A design tool based on PHY Abstraction for performance/complexity trade off analysis: select a subset of specific design/algorithmic options (reduce the design space) based on the QoS and complexity constraints, and the performance estimates of the candidate options.



3. Example of PHY Abstraction for Coded MIMO multi-carrier systems



Link Level compact description for Coded MIMO multi-carrier systems includes:

- Effective SINR Mapping procedure → the most crucial in the PHY abstraction methodology
- MIMO Receiver Abstraction (Effective SISO channel)
- Interference Aware PHY Abstraction
- Practical Transmitter/Receiver Impairments
- Channel Estimation Errors
- Abstraction models for Non-Orthogonal multi-carrier schemes
- PHY Abstraction for H-ARQ

4. Effective SINR Mapping (ESM)

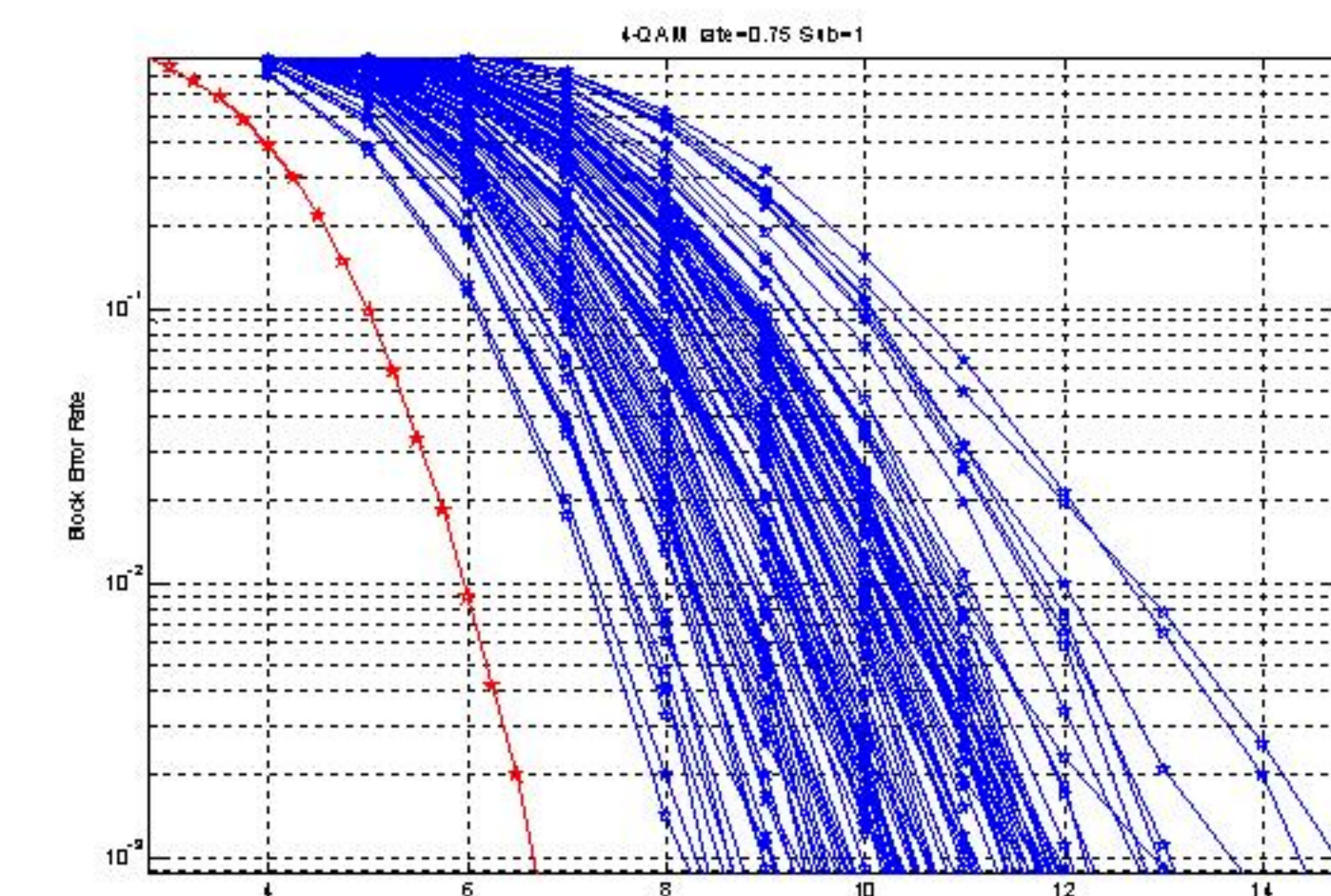
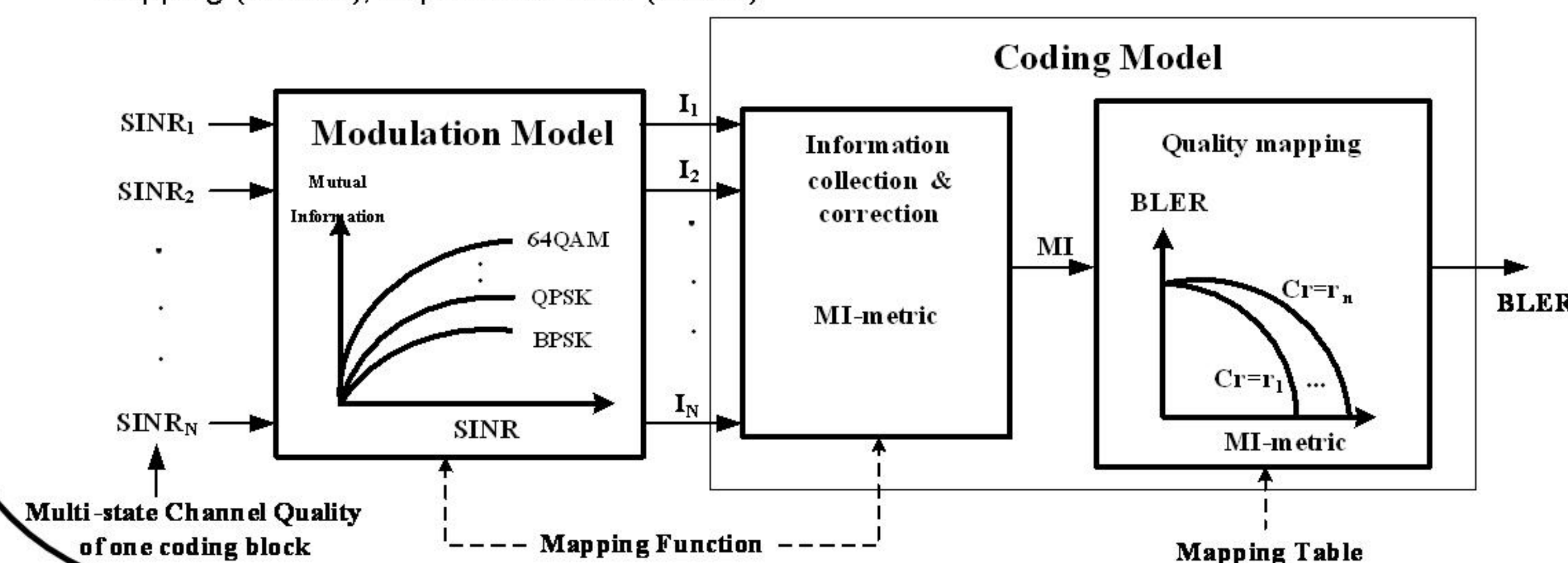
- The task of the *PHY Abstraction* is to predict the coded block error rate (BLER) across the OFDM sub-carriers transmitting this FEC-coded block, for any given channel realization (sample path), *NOT averaged over the channel statistics*.
- Post-processing SINR values at the input to the FEC decoder are considered as the input to the PHY abstraction mapping.
- As the link-level BLER curves are always generated based on a frequency-flat channel for various SINR's, an effective SINR ($SINR_{eff}$) is required to *map* the system-level SINR vector on these link-level BLER curves to determine the resulting BLER.

ESM methods can be described as:

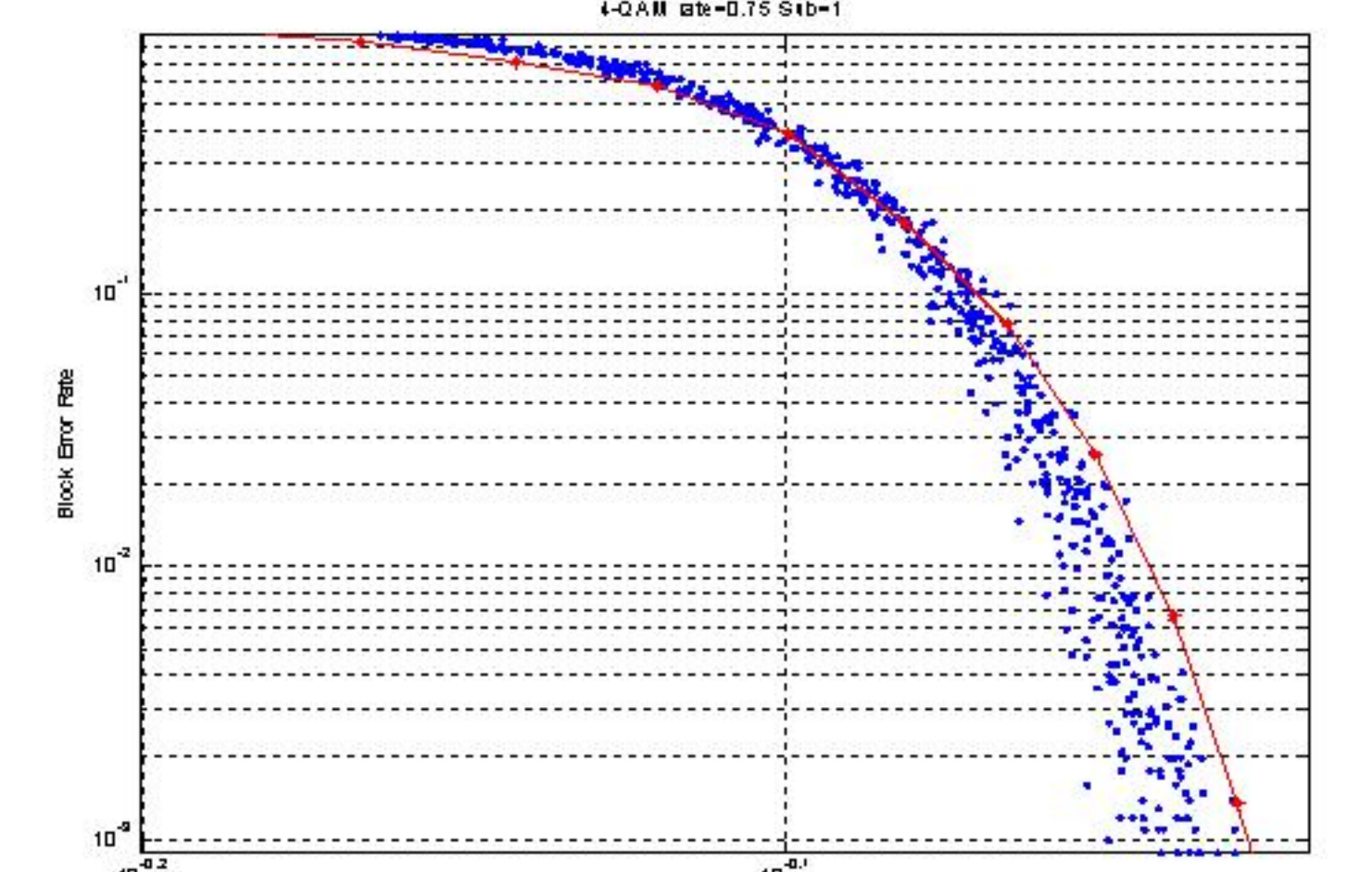
$$SINR_{eff} = \Phi^{-1} \left\{ \frac{1}{N} \sum_{n=1}^N \Phi(SINR_n) \right\}$$

where:

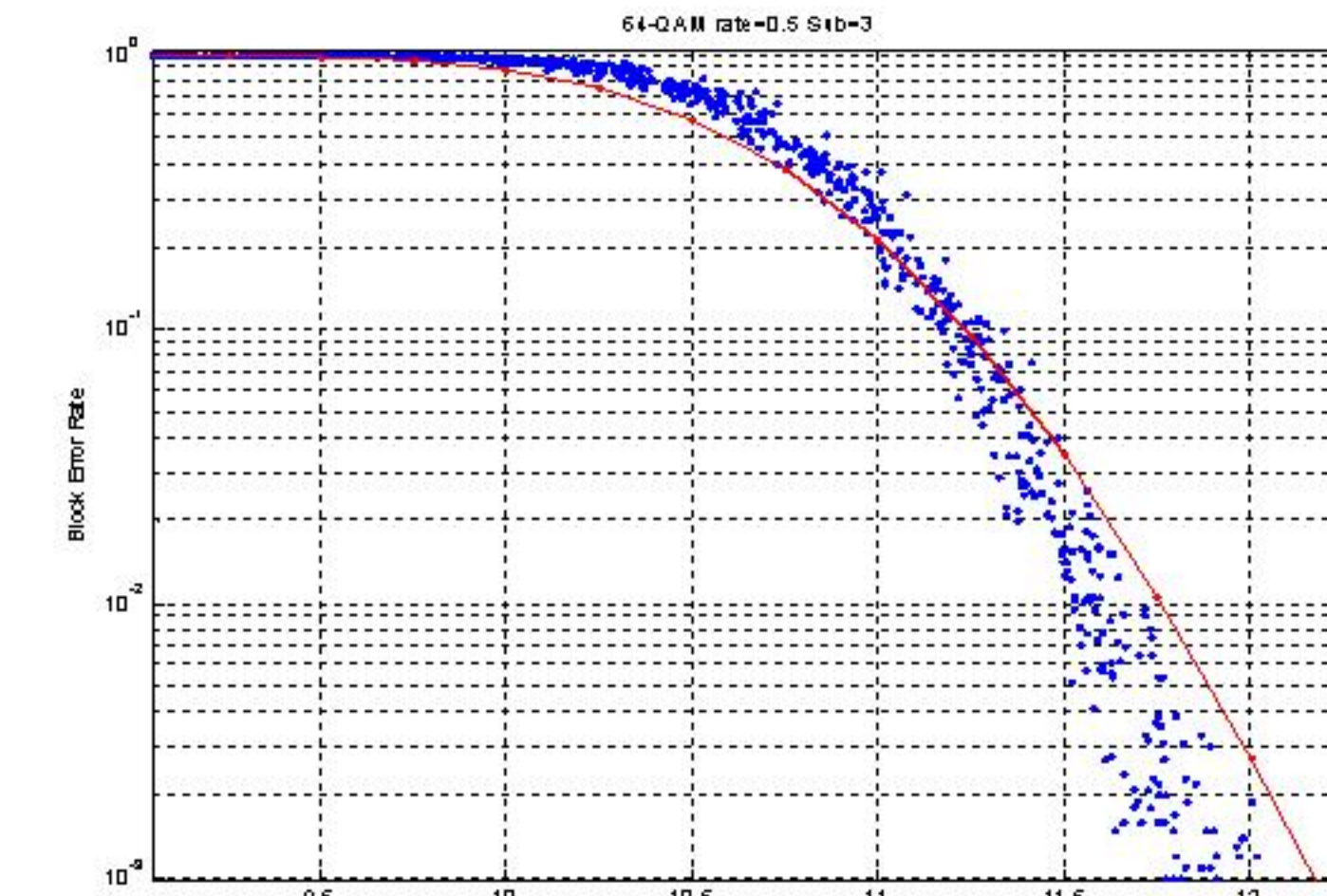
- $SINR_{eff}$ is the effective SINR
- $SINR_n$ is the SINR of the n-th sub-carrier
- N is the number of symbols in a coded block, or the number of sub-carriers used in an OFDM system
- $\Phi(\cdot)$ is an invertible function, with choices such as: Mutual Information Based Effective SINR Mapping (MIESM), Exponential ESM (EESM)



Average SINR as ESM: 4-QAM, rate=0.75, 1 subchannel



MMMB metric: 4-QAM, rate=0.75, 1 subchannel



EESM metric: 64-QAM, rate=0.5, 3 subchannels, Beta=13

• BLER prediction with Average SINR approach fails for frequency selective channels → need for more complex ESM methods.

• MMB and EESM offer low dispersion and good prediction since they are close to the AWGN reference curves.

• Special calibration needed for potential use in an algorithmic (AMC) design

Simulation parameters (IEEE 802.16e):
 Channel Type: TDL Scenario, Pedestrian B (100 different channel realizations)
 Subcarrier Allocation: FUSC, Code type: CTC
 Modulation/Coding schemes (MCS) chosen:
 4-QAM, rate 0.75 for 1 subchannels per coded block (12 bytes)
 4-QAM, rate 0.75 for 6 subchannels per coded block (72 bytes)
 64-QAM rate 0.75 for 1 subchannels per coded block (36 bytes)
 64-QAM rate 0.5 for 3 subchannels per coded block (108 bytes)