



Performance evaluation of ACM procedures using Reed-Solomon decoder assisted switching in HAP operating environment

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Note:

This paper has been accepted for presentation at VTC Spring 2007.

Outline

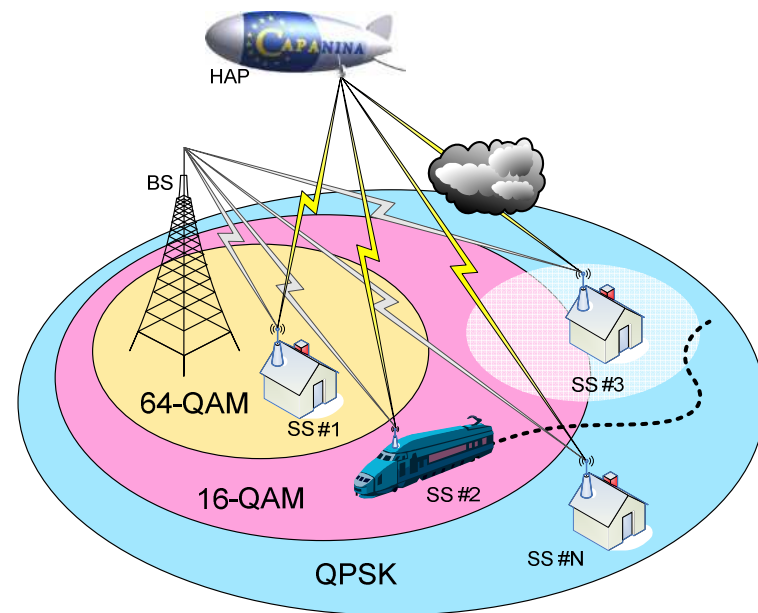


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- Assumptions
 - Working environment
 - IEEE 802.16
 - HAP channel model
 - Implemented ACM model
 - QPKS, 16QAM, 64QAM
 - CAZAC, RS coding
 - Switching points definition
 - AWGN & HAP channel performances
 - Conclusions, future work
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Assumptions

- ITU allocated frequency bands for HAP BWA services are 28/32 GHz and 47/48 GHz
- IEEE 802.16-SC was selected as the most appropriate candidate standard within CAPANINA

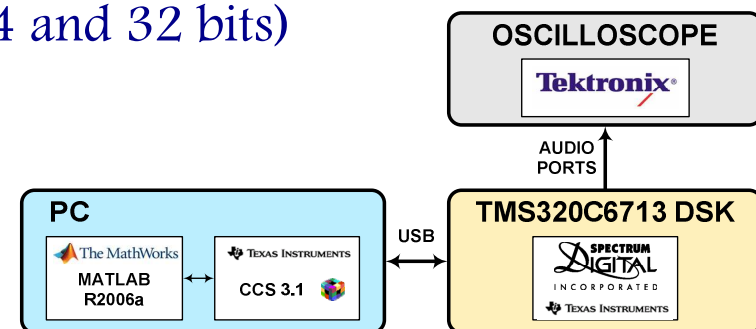
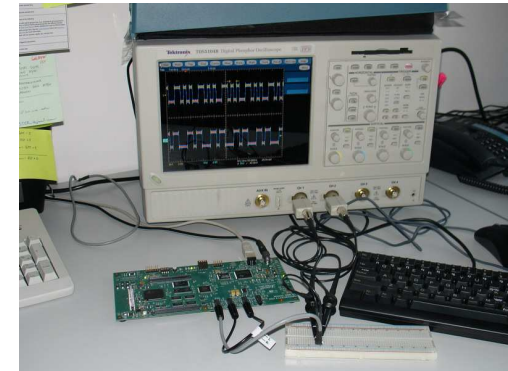
- HAP channel model
- Why ACM?



Working environment



- TI TMS320C6713 DSK Board
 - 225 MHz system clock
 - Processor
 - 32-bit floating-point
 - 8 functional units
 - Onboard stereo audio codec (AIC23)
 - DAC/ADC
 - Variable sample rate (from 8 to 96 kHz)
 - Supported word lengths (16, 20, 24 and 32 bits)
- TI Code Composer Studio v3.1
- MATLAB/Simulink R2006a

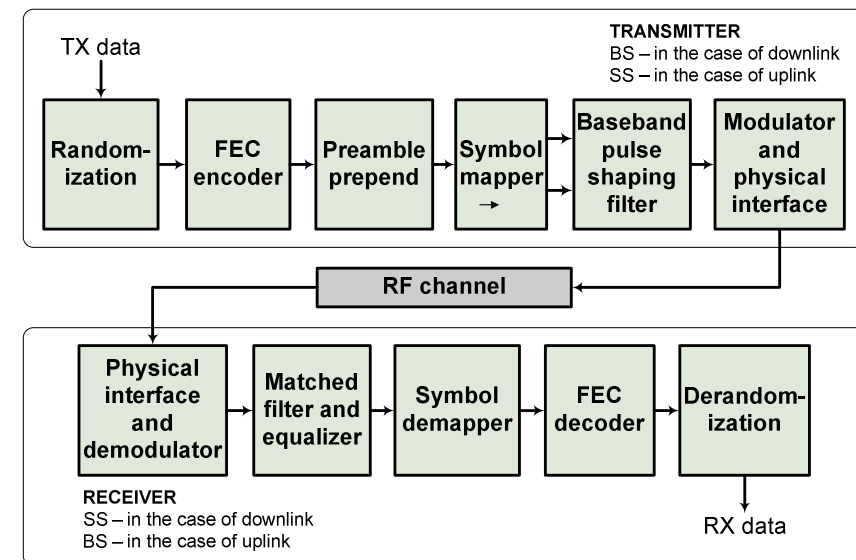


IEEE 802.16~SC



Key functionalities of IEEE 802.16~SC PHY layer

Transmission method	single carrier
Frequency bands	10 – 66 GHz
Channel condition	required line of sight
Bit rate	32 – 134 Mbit/s
Channel bandwidth	20 MHz, 25 MHz, 28 MHz
Duplexing alternatives	FDD, H FDD, TDD
Uplink/Downlink	TDMA / TDM (TDMA)
CAZAC sequence	16 or 32 bit
Modulation	QPSK, 16-QAM, 64-QAM
FEC code types	<ol style="list-style-type: none"> 1. RS only RS(255,239) 2. RS + Block Convolutional Code 3. RS + Parity Check 4. Block Turbo Code
Frame duration	0.5 ms, 1 ms or 2 ms
Roll-off factor	0.25

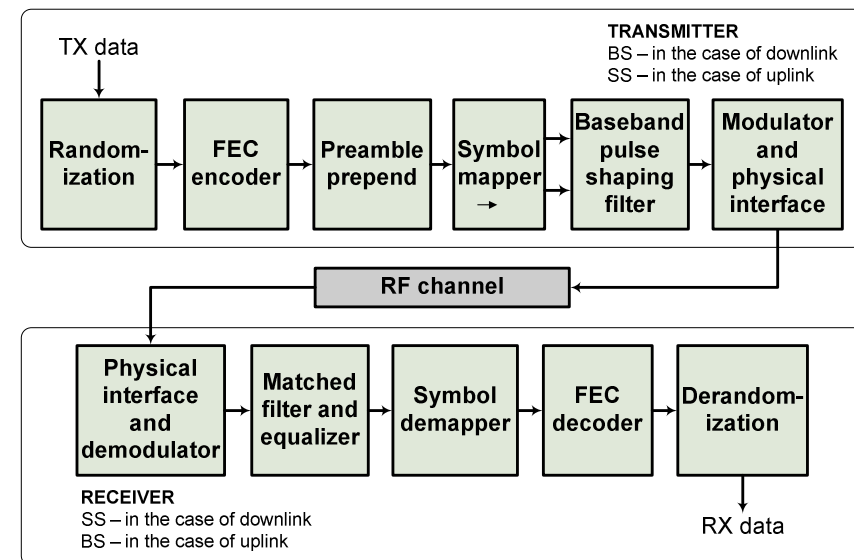


IEEE 802.16~SC

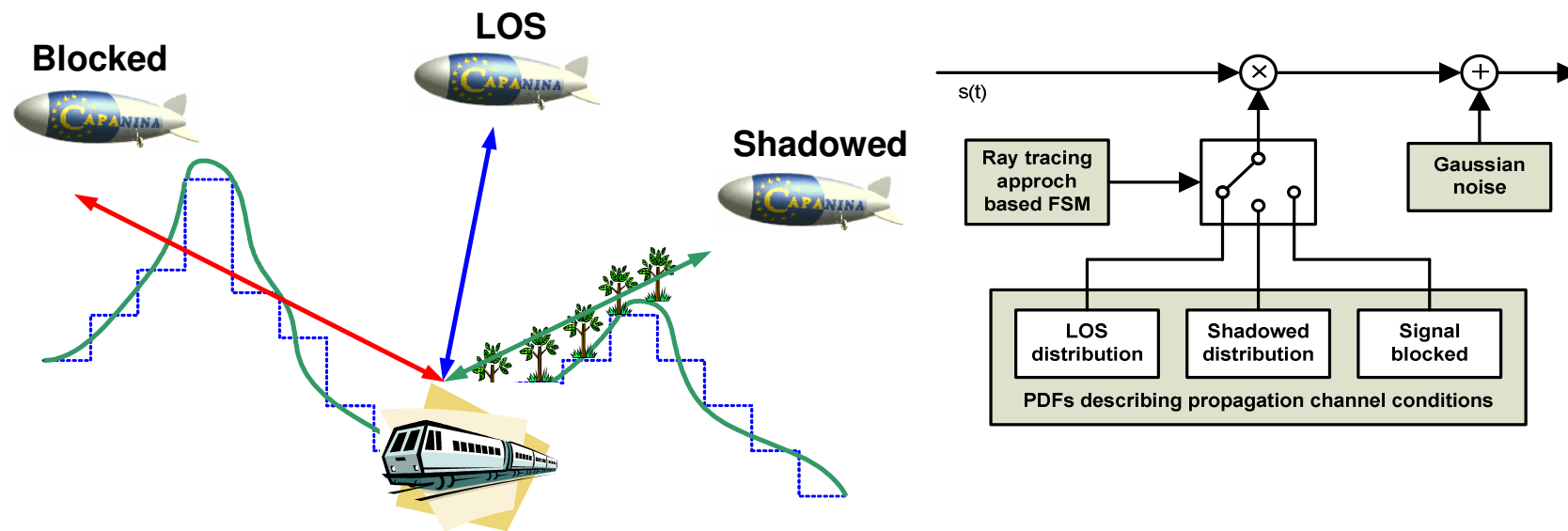


Implemented functionalities of IEEE 802.16~SC PHY layer

Transmission method	single carrier
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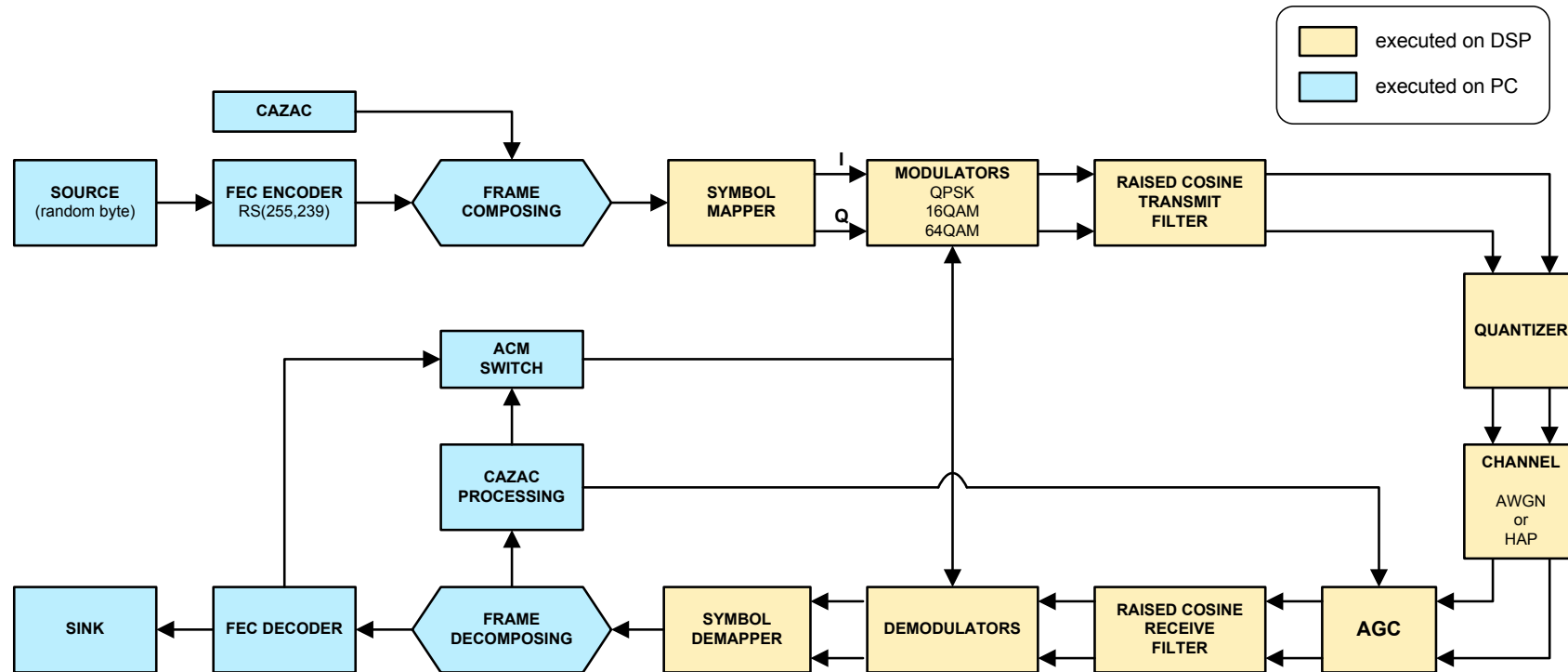


Channel model



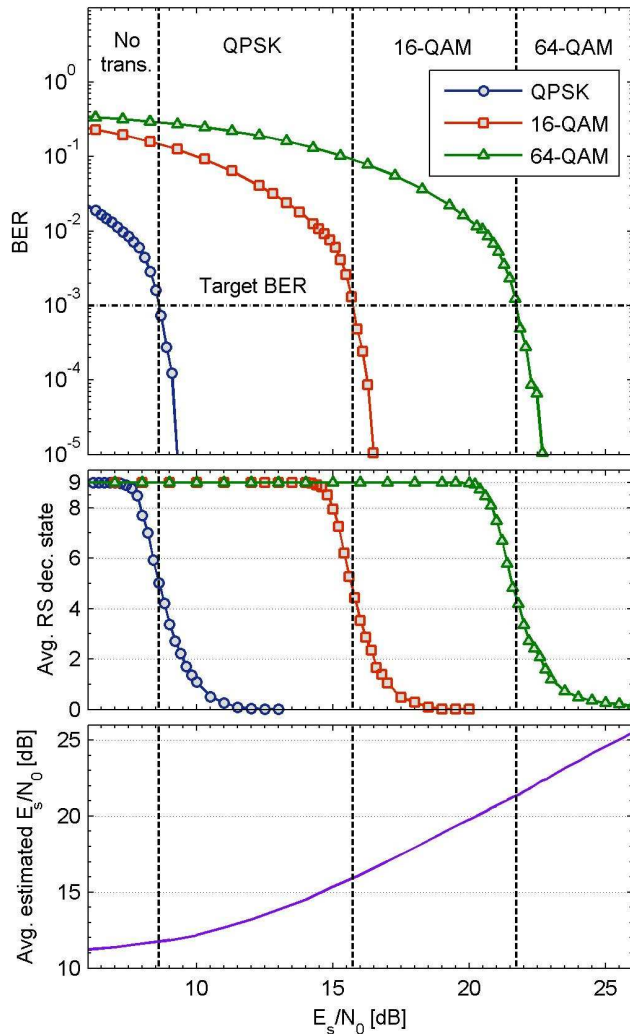
S. Plevel, T. Javornik, M. Mohorcic, G. Kandus, "Empirical Propagation Channel Model for High Altitude Platform Communication Systems", In: *Proc. of the 11th Ka and Broadband Communications Conference*, Rome, Italy, September 25-28, 2005.

Implemented ACM model



CAZAC – Constant Amplitude Zero Auto-Correlation sequence

AWGN channel performances



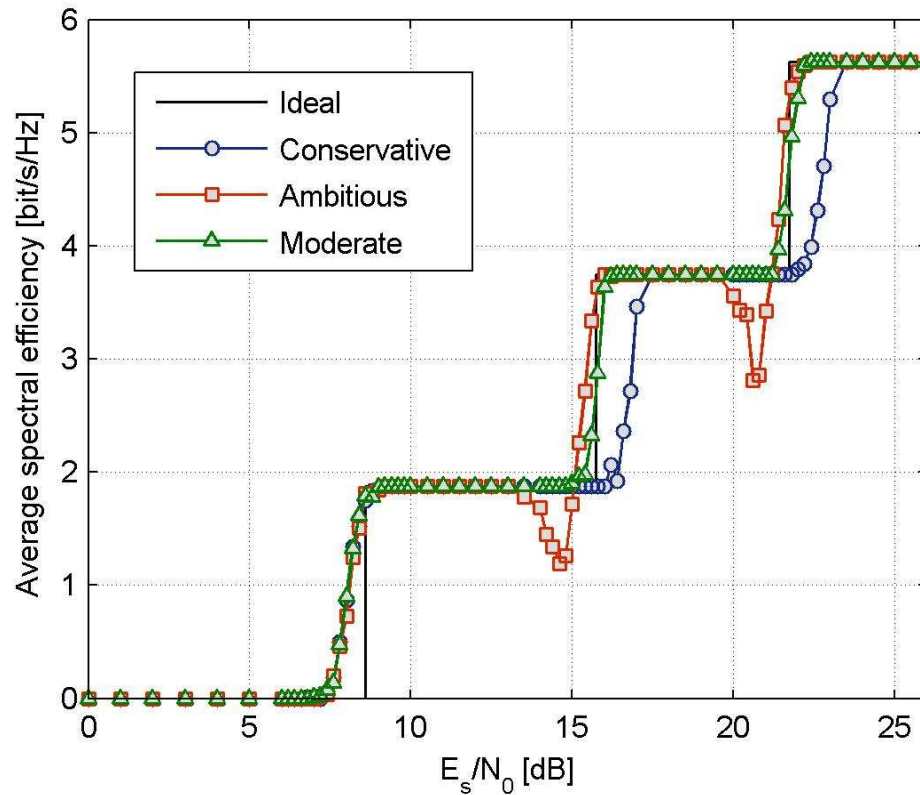
- Model evaluation and switching parameters definition
 - *Conservative, Ambitious, Moderate* scenario
- Estimated E_s/N_0
- RS decoder state
- Target BER 10^{-3}

Switching points definition



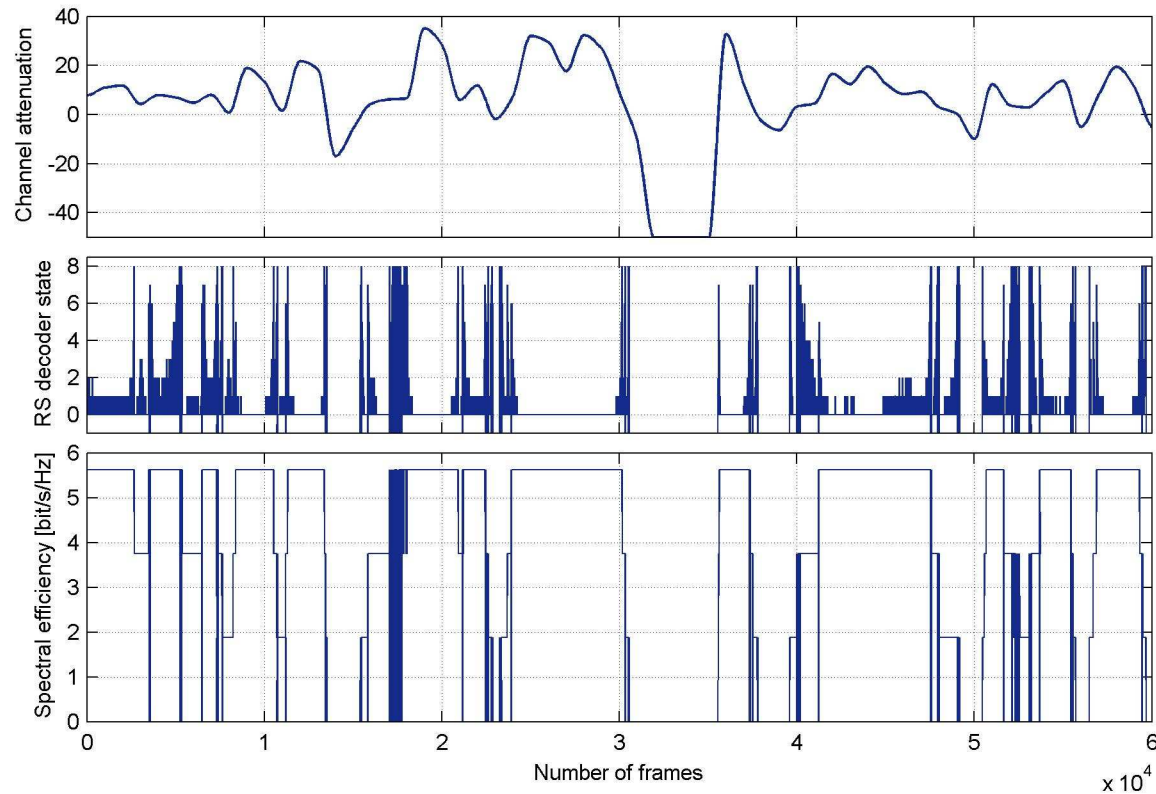
Possible Switches	Conservative		Moderate		Ambitious	
	RS decoder state	estimated E_s/N_0 [dB]	RS decoder state	estimated E_s/N_0 [dB]	RS decoder state	estimated E_s/N_0 [dB]
QPSK \rightarrow 16QAM	=0	≥ 17	≤ 0.2	≥ 16	≤ 0.4	≥ 15
16QAM \rightarrow 64QAM	=0	≥ 22.5	≤ 0.2	≥ 21.5	≤ 0.4	≥ 20.5
64QAM \rightarrow 16QAM	≥ 4.2	≤ 22.5	≥ 5.5	≤ 21.5	≥ 7.4	≤ 20.5
16QAM \rightarrow QPSK	≥ 4.2	≤ 17	≥ 6.5	≤ 16	≥ 7.4	≤ 15

HAP channel performances 1/2



Moderate scenario best meets the *Ideal* switching points for targeted BER 10^{-3} !

HAP channel performances 2/2



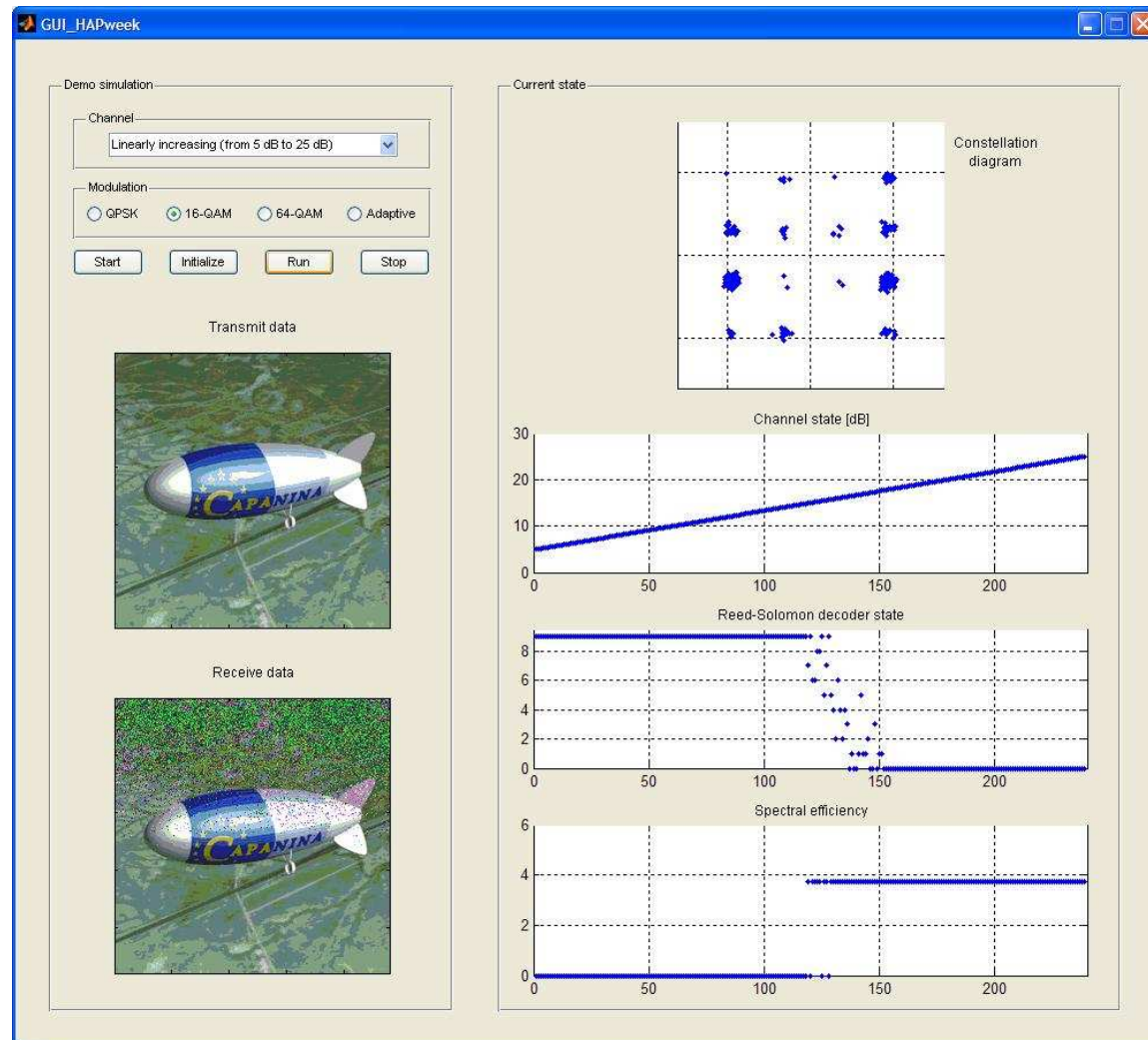
Switching scenario	Conservative	Moderate	Ambitious
Average spectral efficiency [bit/s/Hz]	3.768	3.856	3.881

Conclusions

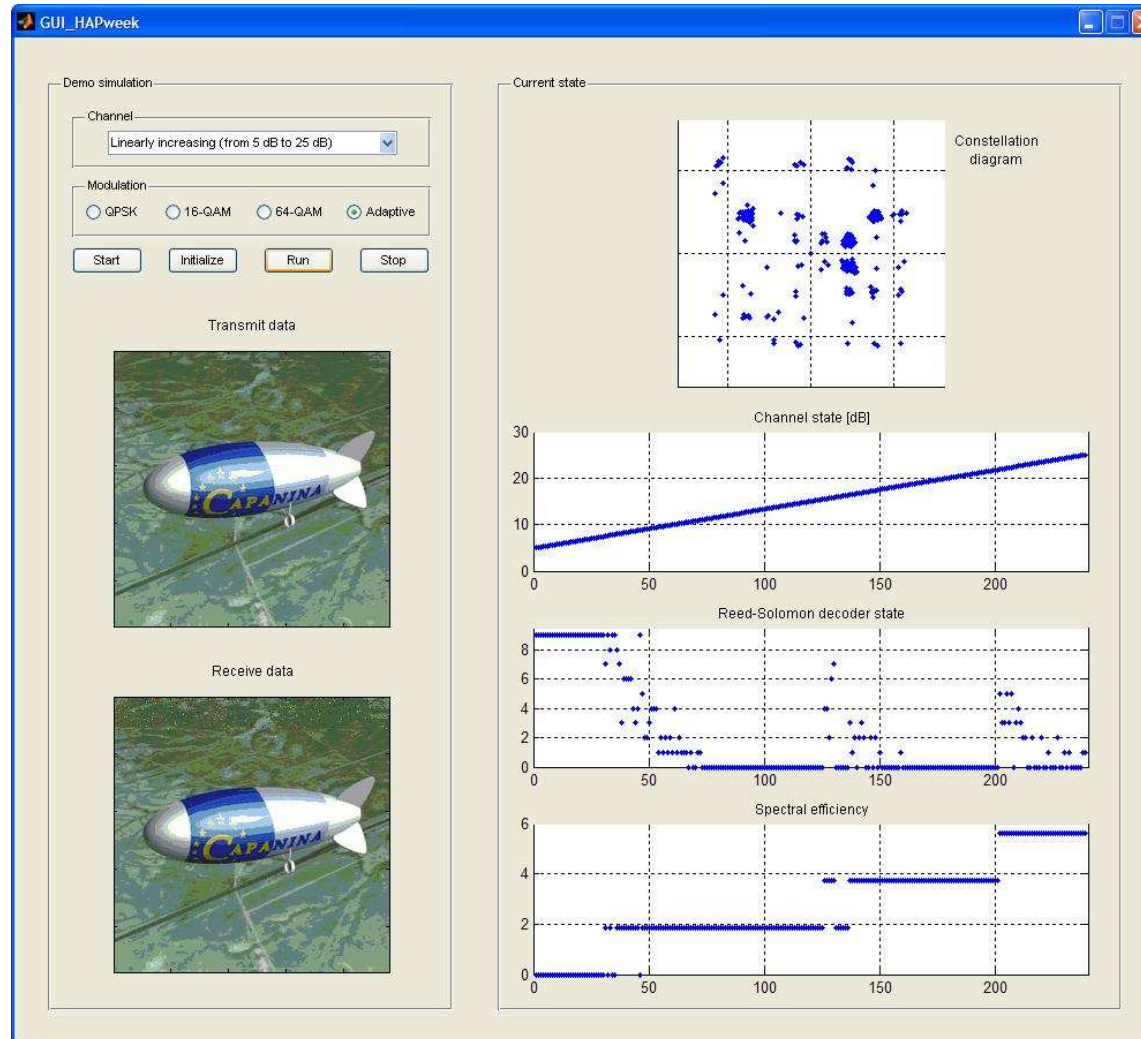


- Where possible *RS decoder state* and *estimated E_s/N_o* can be equivalently used to perform a switch!
 - Switching parameters combining may lead to better performance.
 - Future work:
 - Inclusion of other (mandatory) coding-modulation schemes.
 - Investigation of the switching parameters' influence to the performance of higher layer protocols and their use for cross-layer optimization.
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Demo 1/2



Demo 2/2



Thank you!

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