Modeling and Simulation of Data Transmission in an ADSL Transceiver

Embedded Software Systems
Literature Survey Briefing

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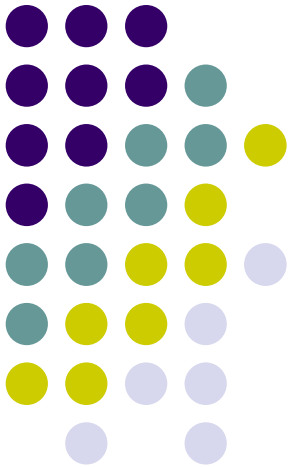
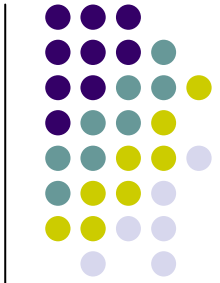
May 03, 2004

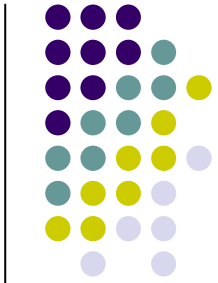


Overview



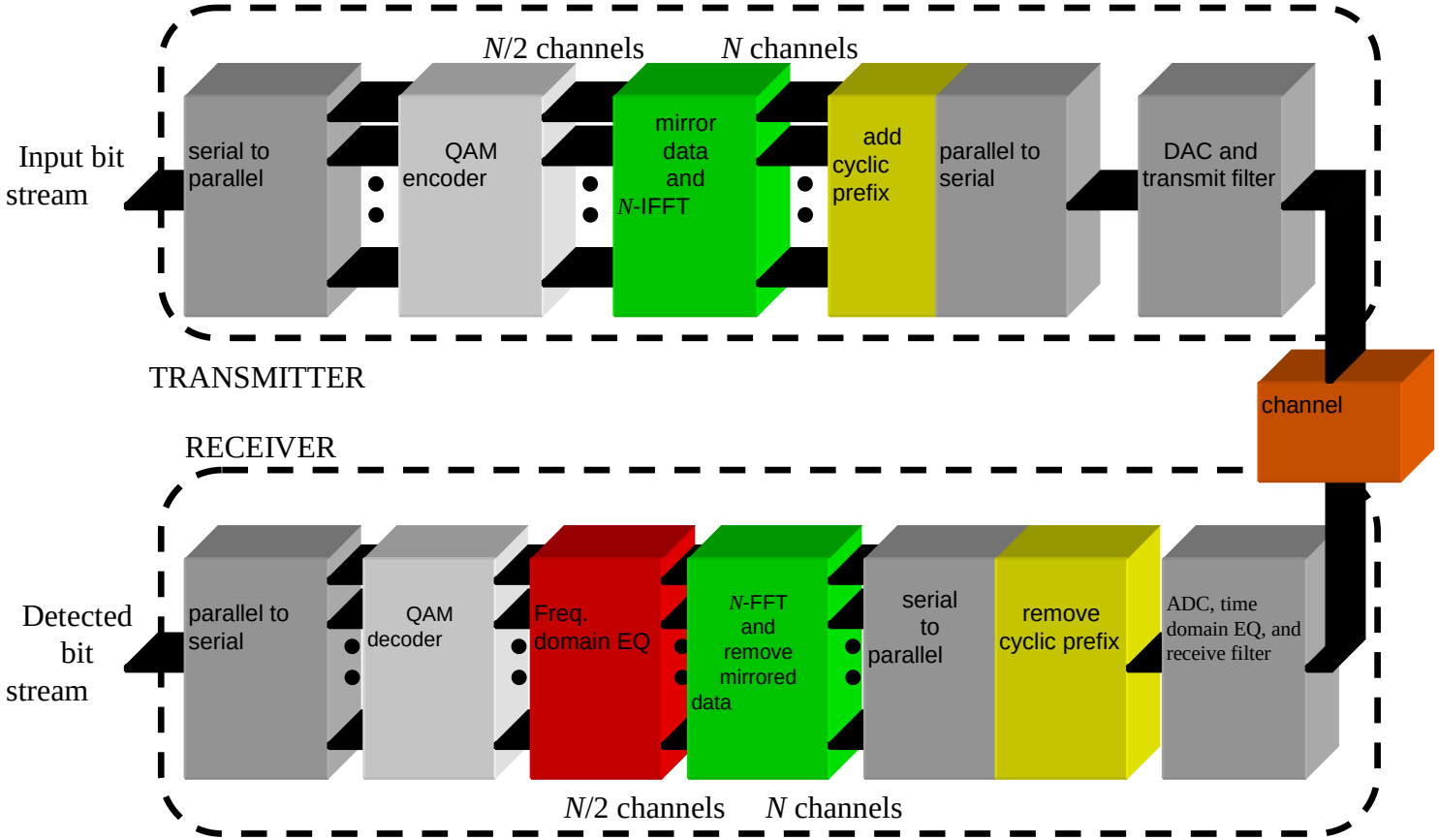
- ADSL Transceiver Architecture
- Problem Statement
- System Modeling
- Implementation
- Conclusion

Literature Overview



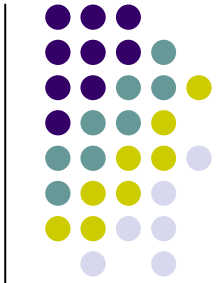
- Quadrature Amplitude Modulation (QAM)
- Inverse Fast Fourier Transform (IFFT)
- Fast Fourier Transform (FFT)
- Cyclic Prefix (CP) Extension: Intersymbol interference mitigation
- Equalization: channel effects suppression
  - Time-domain Equalizer (TEQ)
  - Frequency-domain Equalizer (FEQ)

ADSL Transceiver Architecture



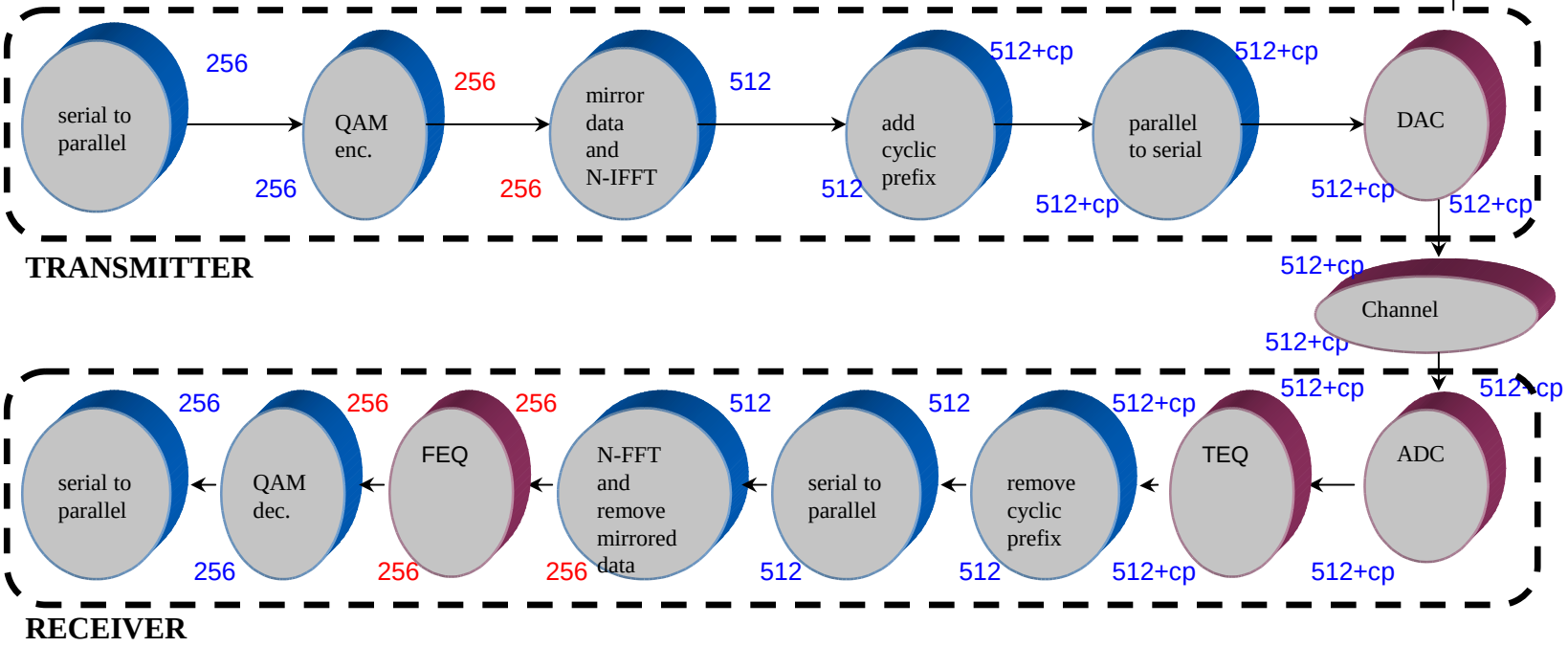
A block diagram of an ADSL transceiver

Problem Statement



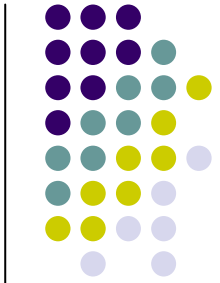
- Design a Synchronous Dataflow (SDF) model for data transmission in ADSL
  - Create an abstraction for Discrete Multi-tone based ADSL modems compliant with the standards
- Implement and simulate the data transmitter and receiver in LabVIEW
  - Implement physical layer functional blocks
  - Make it flexible for designers to modify and optimize the implementation to fit their own design

System Modeling



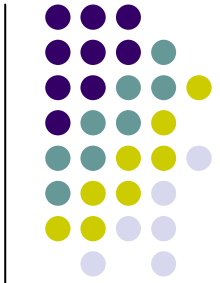
- SDF: best for DSP applications
- 1 token ⇔1 sub-symbol (real/complex number)
- cp ⇔size of cyclic prefix extension

Channel Model



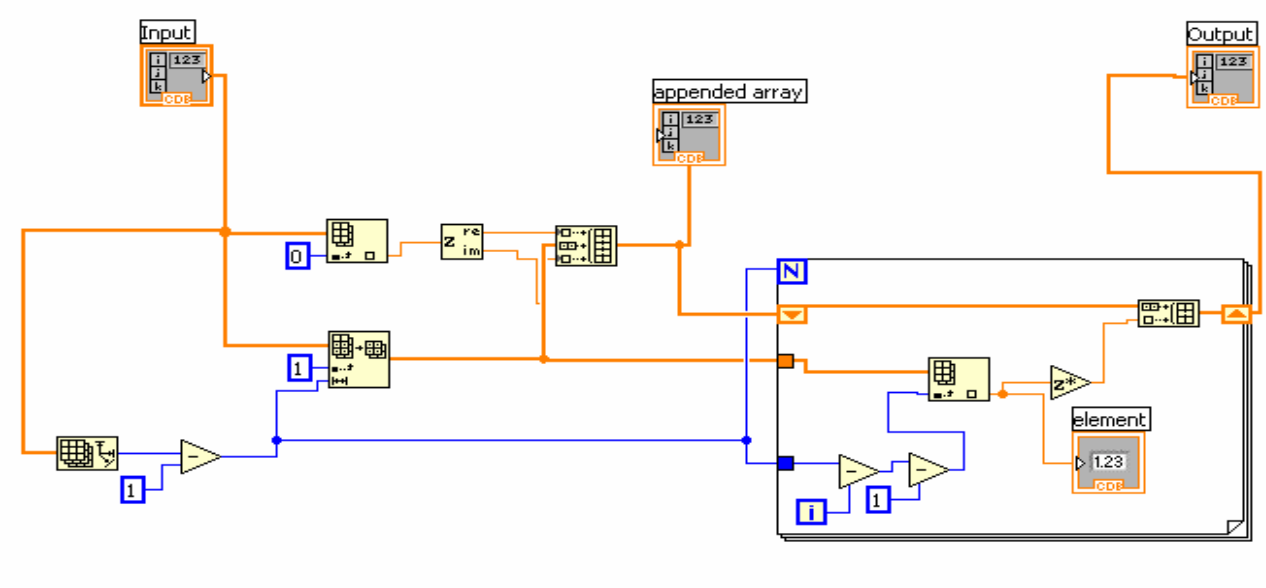
- Carrier serving area loops
- Eight different impulse responses
- Channel impulse response modeled as a finite impulse response filter
  - Computational Model: SDF node
  - Data type on arcs: Real numbers
    - Data Mirroring forces the IFFT to produce real output values

Implementation



- Implement the SDF model for data transmission subsystem using LabVIEW
  - Create a hierarchical design
    - Top-level virtual instrument (VI)
    - Sub-VI for every functional block called by the top-level VI
    - Start-up code: Ian Wong's 802.16a simulation
- Channel Implementation: table lookup for eight different CSA loops.
- Equalization: use Embedded Signal Processing Lab Matlab TEQ Toolbox to generate the TEQ coefficients

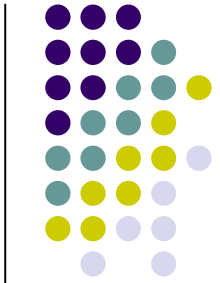
LabVIEW Example



- Data Mirroring Block:
  - Array of size 2M

$$X_i = \begin{cases} X_i & i = 1,\ldots,M-1 \\ \mathrm{Re}(X_M) & i = 0 \\ \mathrm{Im}(X_M) & i = M \\ X_{N-i}^{*} & i = M+1,\ldots,N-1 \end{cases}$$

Conclusion



- Deliverable:
  - SDF model for an ADSL data transmission subsystem in LabVIEW
  - Flexible framework for testing design
    - Choice of channel model
    - Choice of Equalization method
- Future work:
  - Initialization phase
  - Channel estimation
  - Dynamic bit allocation tables

Questions and Answers