Design of a Cognitive Radio-ARchitecture Based on Optimized Time-FreqUency-SignAL Representations (CAROUSAL)

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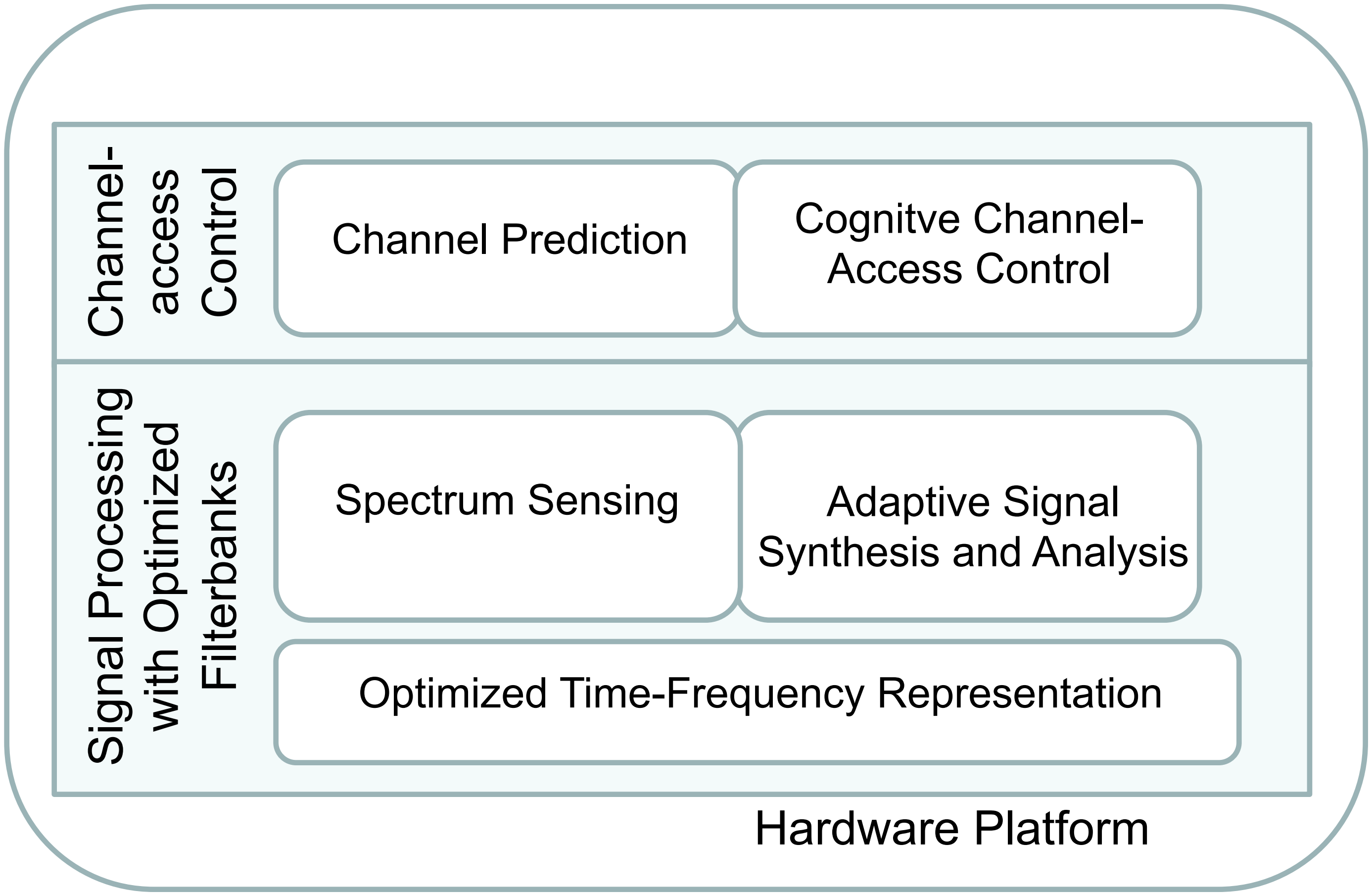
Outline

- Motivation
- System Architecture
- Network Architecture
- Time-Frequency Analysis Using Filter banks
- Spectrum Sensing and Signal Synthesis
- Summary

Motivation

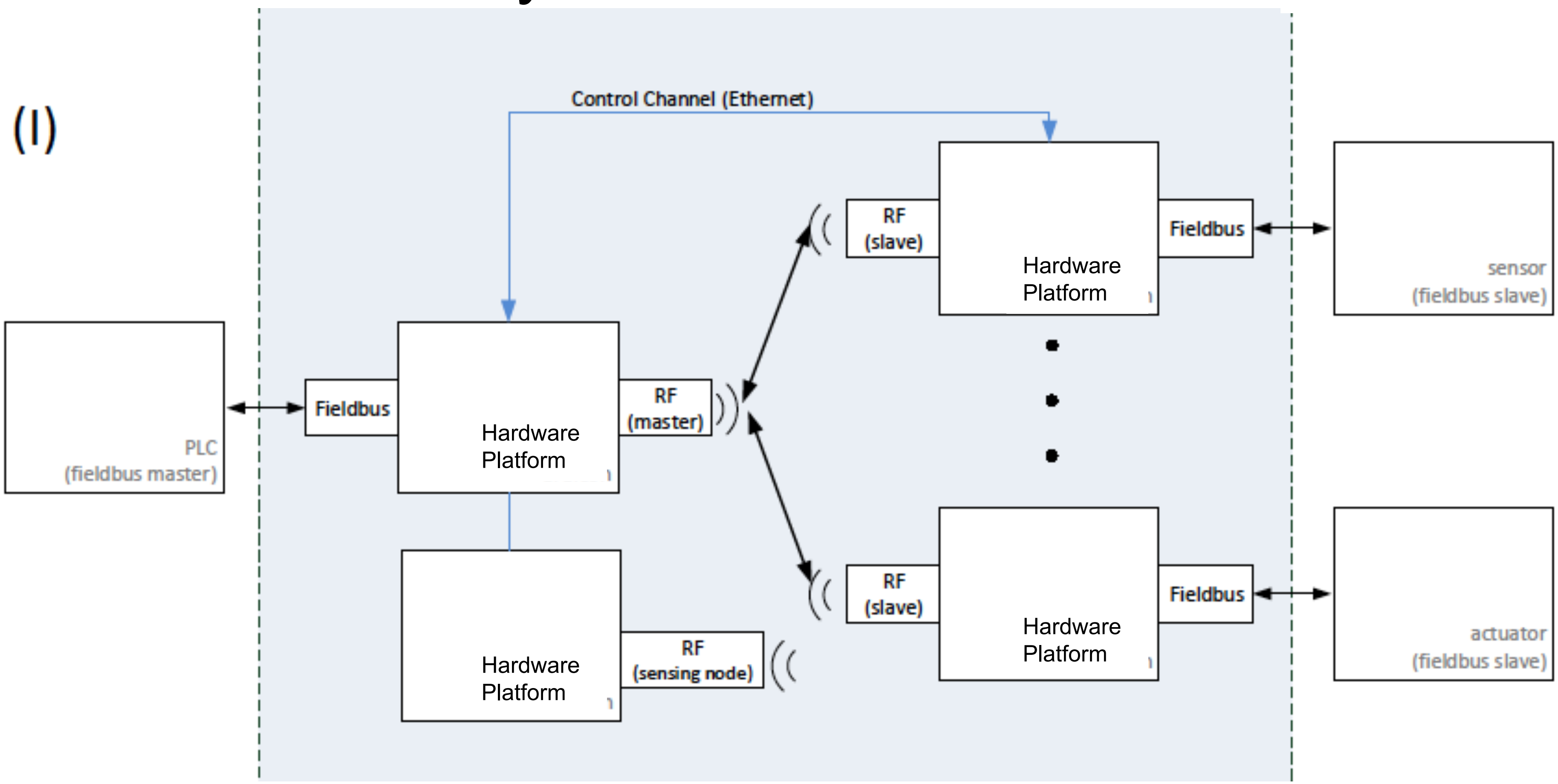
- Tremendous growth in the applications of wireless sensor networks (WSNs) operating in unlicensed spectrum bands.
- Cognitive radio (CR) integrated with wireless sensors can overcome the many challenges in current WSNs.
- Design and implemention of a CR prototype with industrial automation as a main field of application.
- Based on the novel approach of time-frequency signal processing and channel prediction.
- Filter bank based time-frequency realization.
  - Facilitates simultaneous spectrum sensing and reception of secondary transmissions using the same device.

System Architecture



System Architecture

(I)



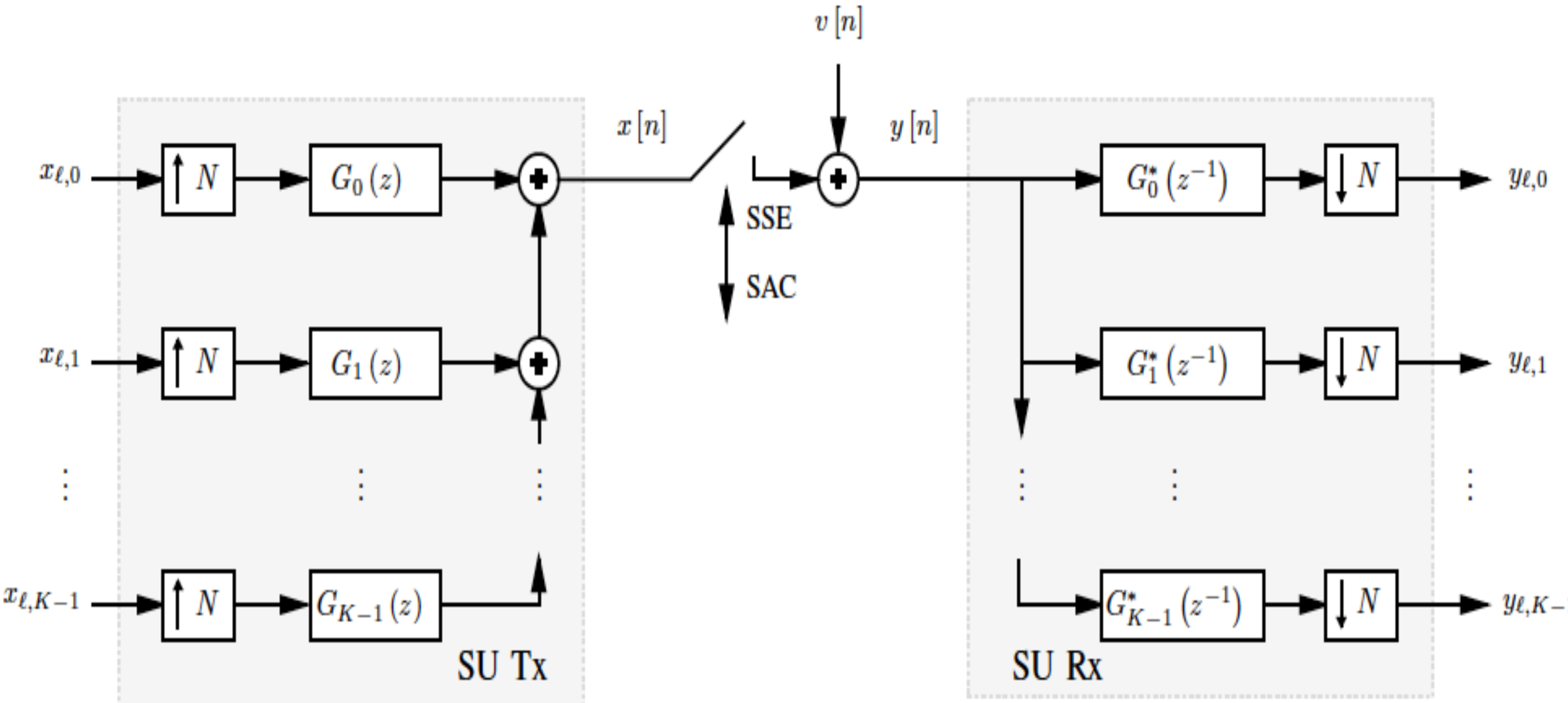
Network Architecture

- Master/slave, with the master granting spectrum access privileges to the slaves based on the output of a prediction block that predicts free white spaces.
- On the MAC layer level, a predictive collision avoidance algorithm that would use prediction to avoid collisions.
- On the PHY level, optimized time-frequency pulses similar to OFDM to be designed, with the implementation being based on filter banks.

Time-Frequency Analysis using Filter Banks

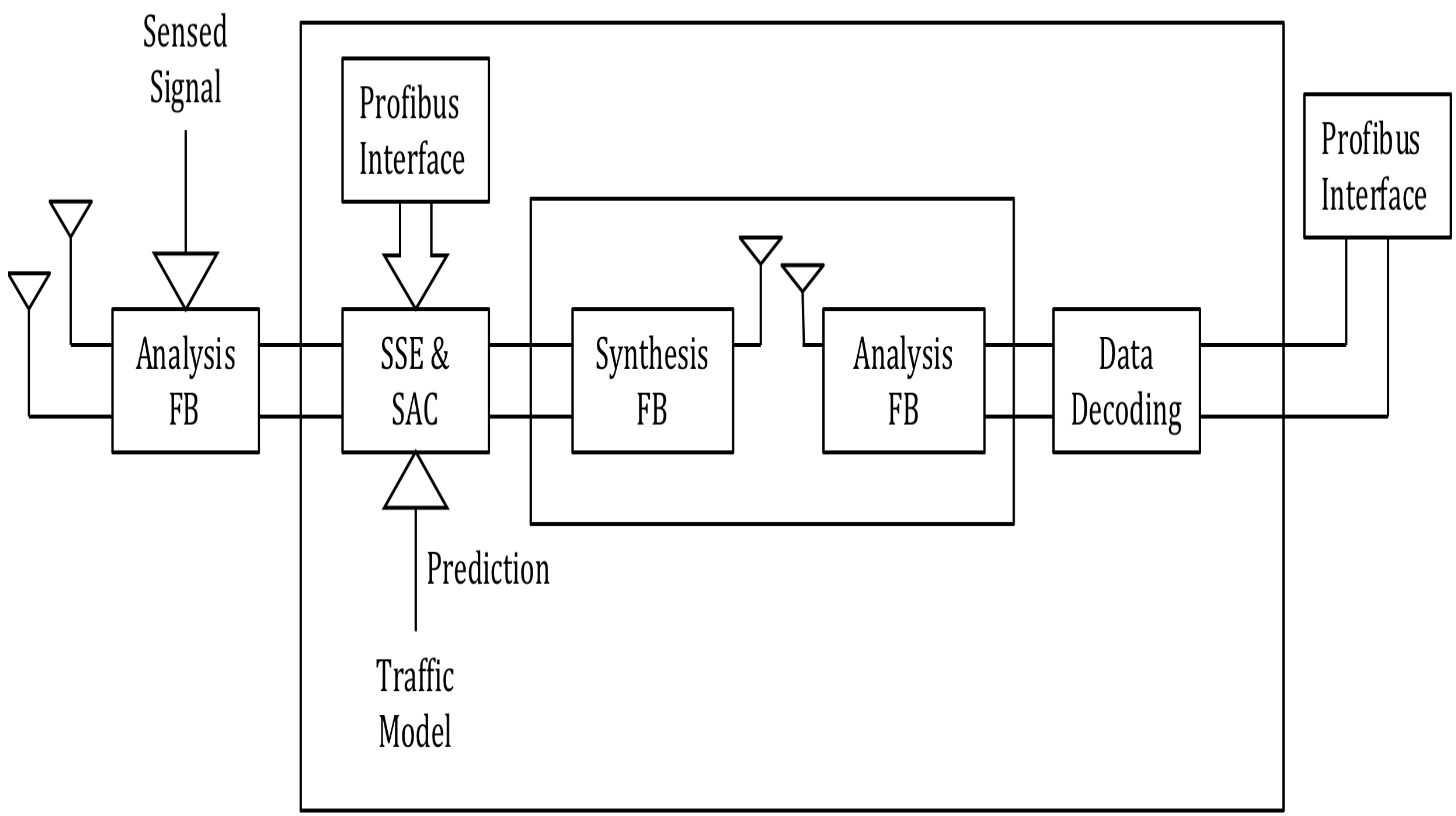
	DFT FB	Gabor frame
$g[k] = d^*[-k]$	analysis prototype filter $d[k]$	Gabor atom (or window) $g[k]$
$w[k] = r[k]$	synthesis prototype filter $r[k]$	Gabor atom $w[k]$
N	down/up-sampling factor	time shift
K	number of sub-bands	frequency shift
$v_m[\ell] = X[\ell, m]$	sub-band signal $v_m[\ell]$	Gabor coefficient $X[\ell, m]$

Time-Frequency Analysis using Filter Banks



Spectrum Sensing and Spectrum Access

- Interference from secondary users (SUs) modeled as a shot-noise process
- Problems arising in classical spectrum sensing techniques in time-frequency domain such as high side lobe level resulting in leakage, low frequency resolution etc. resolved through Gabor analysis.
- Time-frequency concentration can be achieved with a simple constrained optimization which allows to trade performance against complexity.
- Sensing problem reduces to binary hypothesis testing problem


Sensed
Signal
Profibus
Interface
Analysis
FB
SSE &
SAC
Synthesis
FB
Analysis
FB
Data
Decoding
Profibus
Interface
Prediction
Traffic
Model

Summary

- Brief overview of the CAROUSAL project and its use cases.
- System and network architecture.
- Time-frequency analysis using filter banks.
- Spectrum sensing overview.