EVALUATION OF OPTIMIZATION TECHNIQUES FOR SOFTWARE DEFINED RADIO – COGNITIVE RADIO SYSTEM PERFORMANCE

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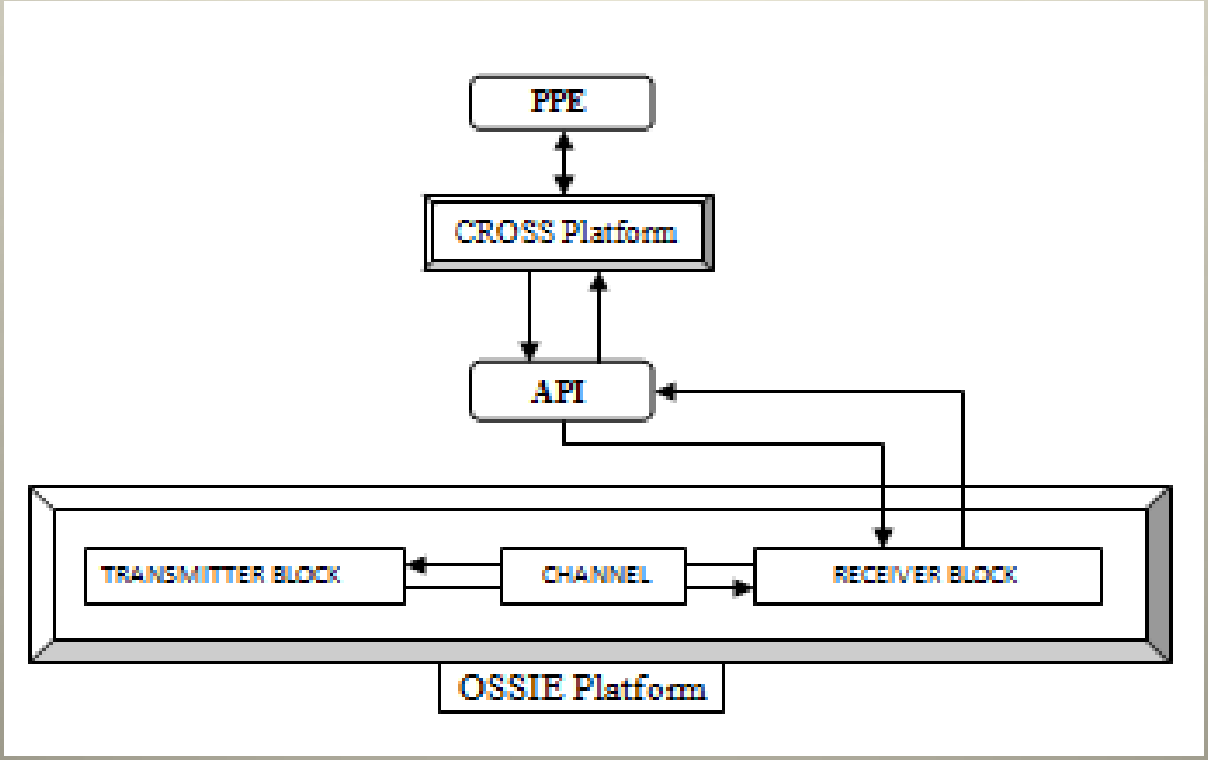
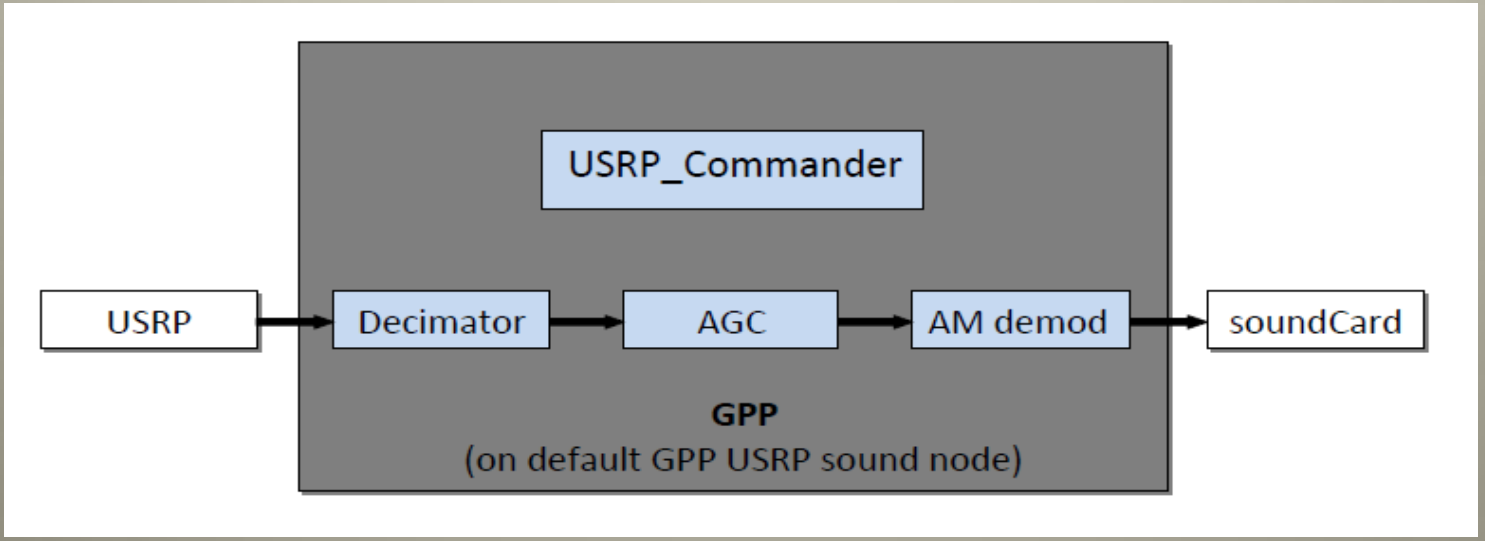
Project Background



Platforms - *1*

OSSIE

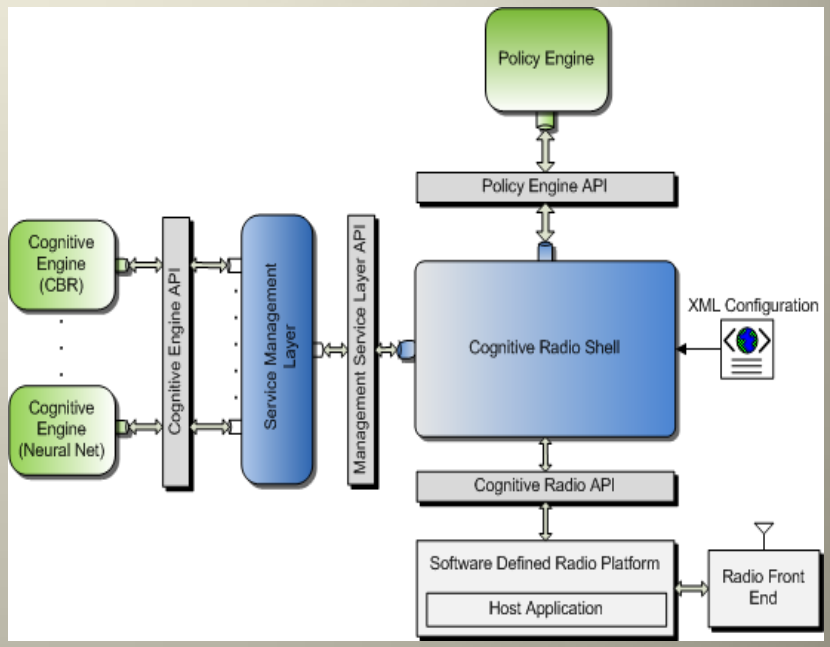
- Open Source SCA Implementation Embedded
- Tunable blocks with signal processing capabilities
- Interfaces with USRPs



Platforms - *2*

CROSS

- Cognitive Radio Open Source System
- Intelligence
- APIs to integrate with other platforms



System Overview - *1*

Learning mechanisms

- Learn the relationship between parameter and utility with trial approach.
- Once the Trend is established, same characteristic is assumed over a period of time before re-verification.

$$Tr = abs(M_y) = \left|\frac{\Delta y}{\Delta x}\right| = \left|\frac{y1-y0}{x1-x0}\right| \quad \ldots\ldots (1)$$

System Overview - *2*

Optimization

- Weights to prioritize the parameters.
- Restrict the domain of parameter variability by TotalWeight formula.

$$TW = P_i \times Pw_i + |(U - U_t) \times Uw \times Penalty| \quad \ldots. (2)$$

$$\text{If } P_n/P_m > Pw_m/Pw_n\,,\ P_m = P_m + 1 \text{ else } P_n = P_n + 1 \quad \ldots. (3)$$

System Overview - *3*

Case Based Reasoning

- Uses experiences for understanding and problem solving.
- Restrict the variability/calculations to a local range.
- No predefined expressions to predict direction of better performance.

System Overview - *4*

Error Tolerance

- Error due to variability in noise in predicting Trends is minimized with averaging over large samples.
- Trend is finalized only after observance over range of parameter values.
- Trend re-verification is performed after intervals of time.
- Fixed step size to restrict parameter values in stable domain.

System Overview - *5*

Multi-utility constraints

- Ability to integrate experiences from multiple radios working under similar channel conditions.

$P_1 > a \;\&\; P_2 < b$ where $a < b$ ----- (1a)

$P_1 < a \;\&\; P_2 > b$ where $a > b$ ----- (2a)

$P_1 > a \;\&\; P_2 < b$ where $a > b$ ----- (3a)

$P_1 < a \;\&\; P_2 > b$ where $a < b$ ----- (4a)

$P_1 < a \;\&\; P_2 < b$ where $a < b$ or $a > b$ ----- (5a)

$P_1 > a \;\&\; P_2 > b$ where $a < b$ or $a > b$ ----- (6a)

System Overview - *6*

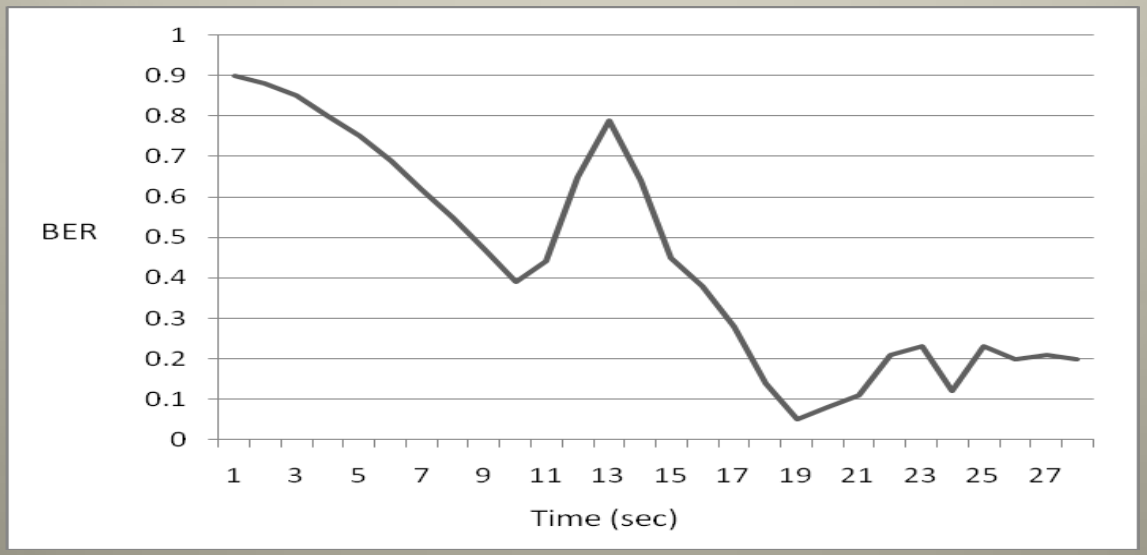
Limitations

- System initial state critical in learning process.
- Slowness of system to reach optimal state due to fixed step size and limitations on both platforms.
- All cases of multi-utility constraints not supported.
- Dependencies between parameters neglected.

Experimental Results

Parameters : Transmit Power, Modulation Order, Coding Gain.

Utility : Bit Error Rate(BER)



Conclusion

- Minimized computational complexity.
- Improved radio system performance.

Future Work

- Evaluate bi-directional approach and multi-utility constraints.
- Evaluate performance with other parameters like multiple antennas(MIMOs), Coding Techniques.
- Evaluate performance with other utilities like Bandwidth, Data rates.

Reference

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Thank you