

CTM OPEN DAY 2015

PhD Presentations

One Minute Madness

CONTEXT-AWARE PERSONALIZATION FOR MOBILE MULTIMEDIA

OBJECTIVES

To develop a conceptual framework for context-aware personalized multimedia recommendations for mobile users

by :

- Developing &
- Incorporating a new contextual approach for implicit & proactive content recommendations in mobile environments.

RESULTS/CONCLUSION

- A smartphone context sensing and management system.
- A contextual user preference and profile model.
- Contextual recommendation processes for implicit & proactive multimedia content suggestions.
- 1 Journal, 1 book chapter and 6 conference papers(peer reviewed)

• *Improving User Multimedia Content Consumption experience using:*

- ❖ **Context Awareness Framework:** Sensing, recognizing, characterizing, and inferring high-level contextual information(which influences user's preferences) from Low-level contexts.
- ❖ **Contextual Mobile User Profile:** For tailoring delivered content presentations according to User preferences and contextual constraints.
- ❖ **Contextual Content Recommendation algorithms:** For delivering relevant media content to users , driven by their contextual preferences.



IRIS AND FINGERPRINT RECOGNITION

OBJECTIVES

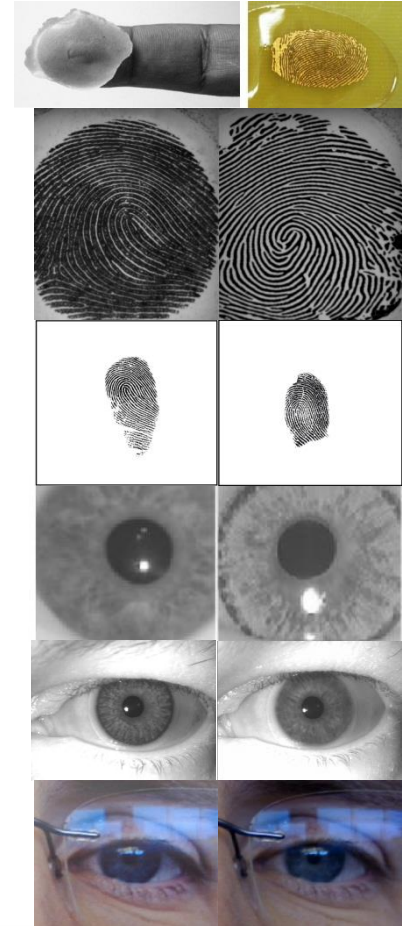
Some of the main objectives are:

- development of robust iris detection methods in unconstrained settings;
- application of learning methods to the improvement of the iris liveness detection process;
- development of new approaches for the fingerprint liveness detection problem using semi-supervised learning methods (one-class methods);
- Improvements to the enhancement and binarization steps in a fingerprint recognition system.

RESULTS/CONCLUSION

- Organization of an **iris liveness detection competition** using a house-in built benchmark (MobILive 2014).
- Presentation of its results in a **international top conference** in the biometrics field (IJCB 2014).

- Biometric Recognition Systems are vulnerable to **Spoofing Attacks**.
- These are **attacks at sensor level** carried on by presenting a **fake sample** from an authorized user.
- The **liveness detection** step is of great importance in any BRS.
- Well known liveness detection methods can be combined with **learning techniques** to tackle more difficult approaches, such as restricting the prior knowledge about the materials used in spoofing.
- In the **Mobile Biometrics** field, liveness detection is of utmost importance.



RFID BASED UWB RECEIVER FOR WSN APPLICATIONS

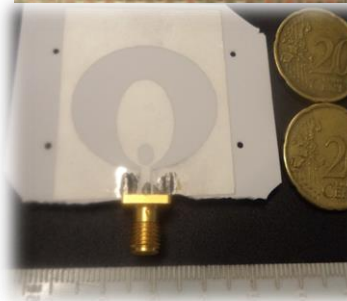
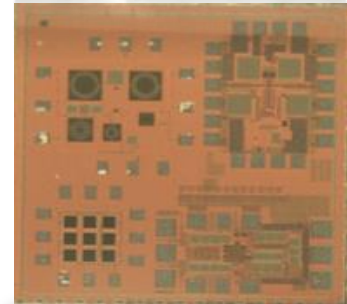
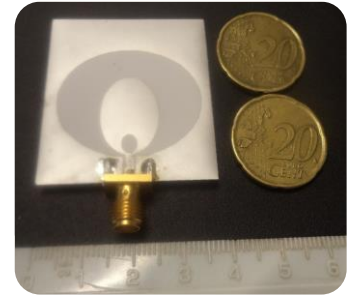
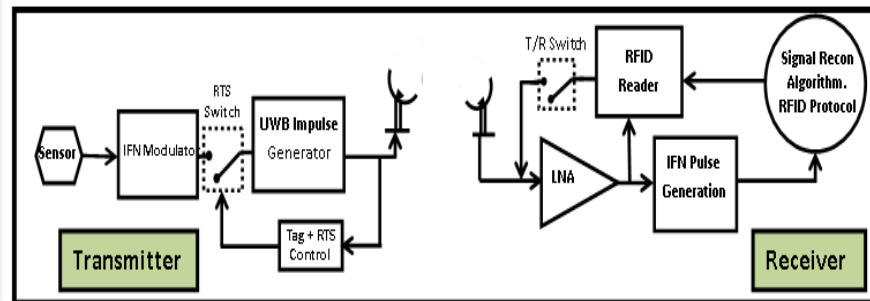
OBJECTIVES

To build a battery-less, reliable, and cost effective solution for Wireless Sensor Networks with insured multiple access capabilities and higher data rates for integration in IoT scenarios.

RESULTS/CONCLUSION

- Designed and tested different RF blocks: Low Noise Amplifier, UWB Antennas using Ceramic and Flexible substrates

- Sensor Nodes will consume power in the range of (μ W), thereby drawing all needed power from environment
- Back scattering passive RFID tags will provide guaranteed Multiple access to all sensor nodes
- Sensors will transmit information without digital conversion into bits
- Sensor nodes will communicate to a central reader which will transmit the information over different data networks (WiFi, 3G/4G)
- Integration with different materials makes it ideal choice for IoT



QoE DRIVEN SERVER SELECTION FOR VoD IN THE CLOUD

OBJECTIVES

- We believe that end-users have the best perception of server performance in terms of their QoE rather than the servers themselves.
- We propose VoD server selection schemes that dynamically select servers according to user's QoE feedback.

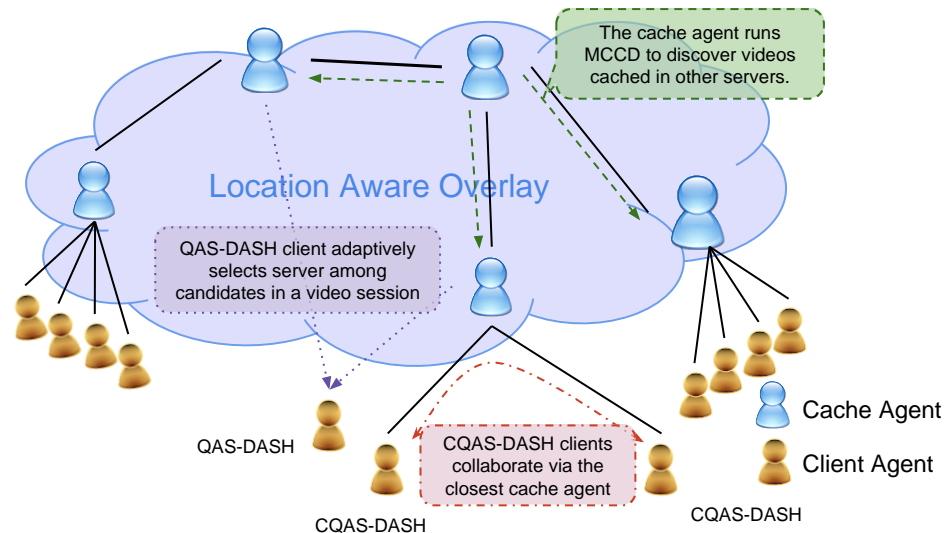
RESULTS/CONCLUSION

- In Google Cloud Experiments,, the average bit-rate of 80% streaming sessions were doubled.
- In large scale simulation, the QoE guaranteed for 90% of users could be increased by 20%.

BACKGROUND

- The VoD provider generally selects a server for the user request according to the user's location.
- When VoD migrates to the Cloud, the server and network performance vary dynamically as the resources are shared and Cloud users neither have control nor visibility of the resources.

SYSTEM DESIGN



CONTRIBUTIONS ON DEEP LEARNING

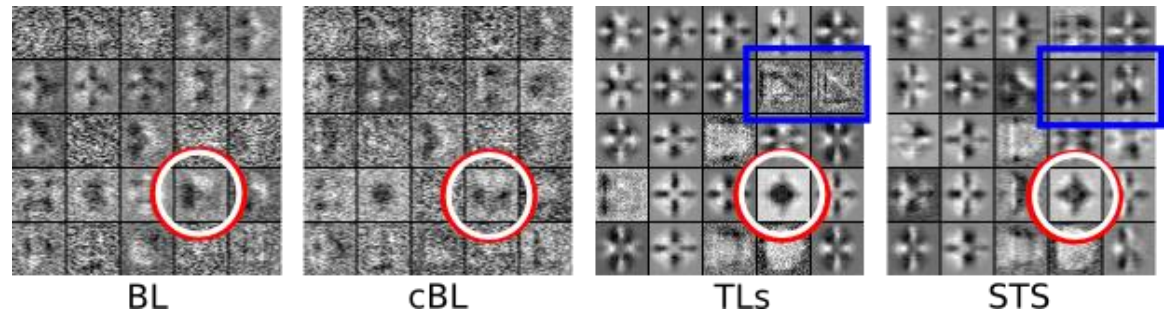
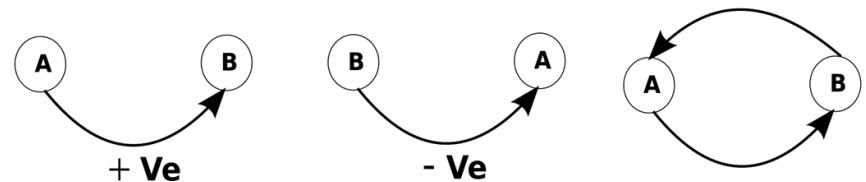
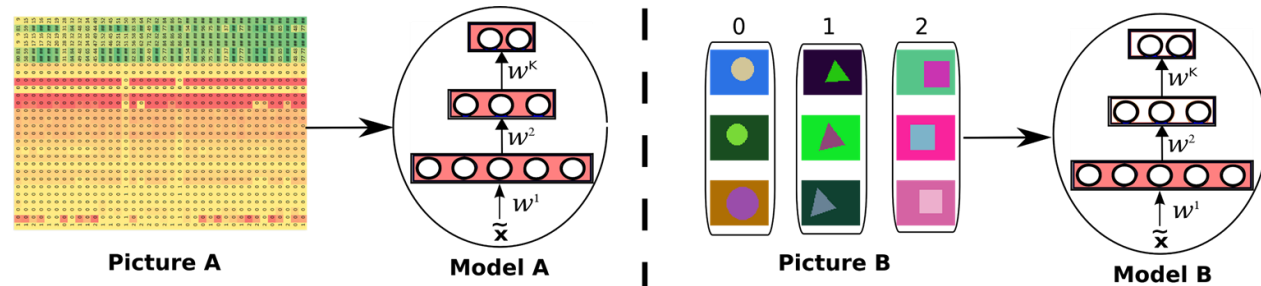
OBJECTIVES

- Deep Learning
- Deep Transfer Learning
- Source-Target-Source
- Deep Transfer Learning Ensemble

RESULTS/CONCLUSION

WE OBSERVE A RELATIVE IMPROVEMENT OF 81% FOR THE SAME TASK USING 0.05% OF THE TOTAL TRAINING SHAPES DATA

A picture is worth 1000 words, and understanding the meaning of 1000's of words is challenging. Train a model to extract hierarchical information from the picture and enable it to understand its abstract patterns.



EXPLORING SENSORS' FUSION ON THE DESIGN OF DEPENDABLE MEDICAL ELECTRONIC SYSTEMS

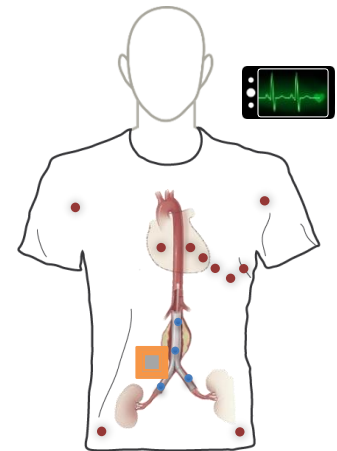
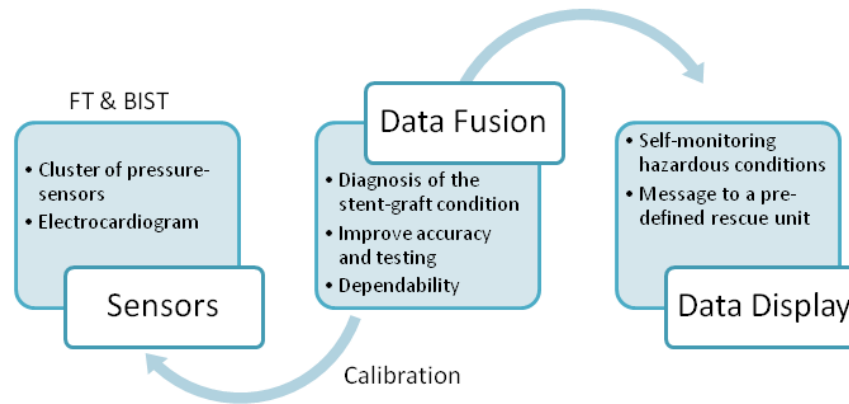
OBJECTIVES

- Development of a dependability model for wearable medical monitoring. The system's risks of not achieving acceptable levels of dependability will be identified using a fault tree analysis. Fault detection and fault tolerance/reconfiguration techniques will be used to detect system malfunctions and correct them.

RESULTS/CONCLUSION

- Aortic pressure monitoring system comprising fault detection features.
- Characterization and validation of pressure sensors.
- Characterization of textile antennas and electrodes.

- Development of a new non-invasive aortic stent-graft monitoring system based on RFID technology. Signal fusion techniques and dependability analysis are explored to obtain the best levels of performance, trust and dependability.
- The monitoring system uses an inductive coupling interface to capture the pressures given by a cluster of sensors placed on the stent-graft's wall. The processing of this set of signals with other physiological signals – electrocardiogram (ECG) and arterial blood pressure (ABP) – allows obtaining better monitoring resolution and reliability.
- Very low power consumption and intrinsic low noise design techniques will be explored to implement the system on a monolithic support using a MOS technology.



HUMAN ACTIVITY PERCEPTION WITH CONTEXT MODELING IN A DATA-DRIVEN APPROACH

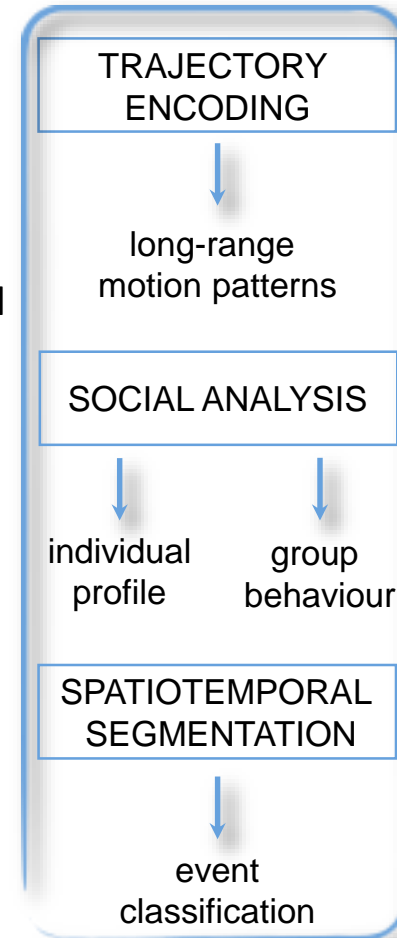
OBJECTIVES

- Mid-level motion representations to detect common motion patterns, and identify unusual ones.
- Spatiotemporal detection and classification of social behaviour.

RESULTS/CONCLUSION

- Long-range global motion trajectories for pattern detection.
- Context-based descriptor to identify individual profiles and group behaviour.

- Visual processing framework to identify and classify human activity in diverse pedestrian scenarios (crowds, structured and unstructured scenes, and multi-tracking, with sparse and dense groups).
- Combination of temporal integration of global flow with local flow energy field in terms of entropy to extract long-range motion trajectories.
- Integration of relational position-based and attention-based features into a multi-scale histogram descriptor to characterise individual-collective context.
- Spatiotemporal segmentation and representation of relevant motion components to classify multimedia events.



MUSIC COMPOSITION WITH SPACE

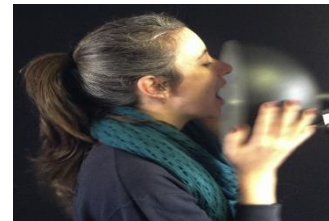
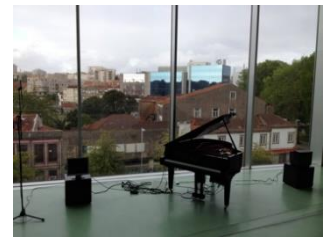
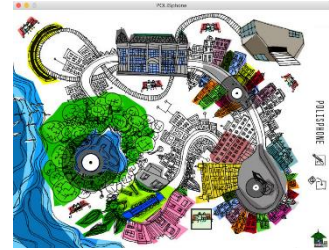
OBJECTIVES

- Analyze the role of space in music composition
- Devise a compositional model where space, in its plenitude, leads both the creative process and the interpretation

RESULTS/CONCLUSION

A holistic musical compositional approach based on the concept of complicity between music composition and space

The word complicity is used to define the influence of space in the musical composition because it reinforces the idea of space and sound being articulated but also envisages numerous levels of engagement. Rooted in that idea, I define what is musical composition in space, musical composition for space and finally, musical composition with space. The latter is the richest form of complicity, consisting of three different but complementary steps: the repertoire of articulations, the systematization of the repertoire of articulations and the musical performance.



A NOVEL MAC FOR UNDERWATER RADIO COMMUNICATIONS

OBJECTIVES

- Design **novel radio MAC** for optimal underwater IP comms
- Develop ns-3 based simulation framework for underwater radio comms
- Develop prototype using SDR platform

RESULTS/CONCLUSION

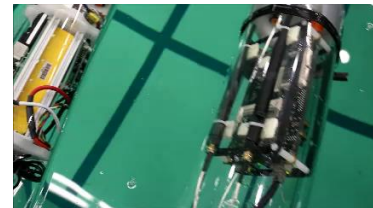
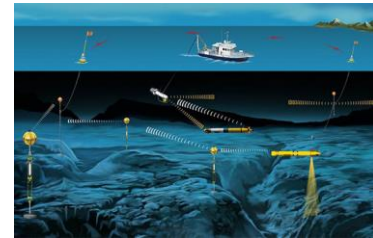
- Experiments with 802.11-based underwater radio networks
 - up to 2.15m @770 MHz
- Ongoing low freq. tests with SDR
- Study on rate adaptation mechanisms in underwater environment → AARF is the best

• Motivation

- Recent R&D area with impact in maritime IoT
- SoA mostly focused on acoustic comms
- No low-cost, broadband underwater radio comms solution available
- RF feasible for broadband, short range comms

• Approach

- Develop an underwater radio comms simulation framework
- Study of 802.11-based underwater networks using ns-3 and underwater testbed
- Design novel MAC to cope with high attenuation and intermittent links
- Evaluation of novel MAC in SDR platform



SYNCOPIATION AS TRANSFORMATION

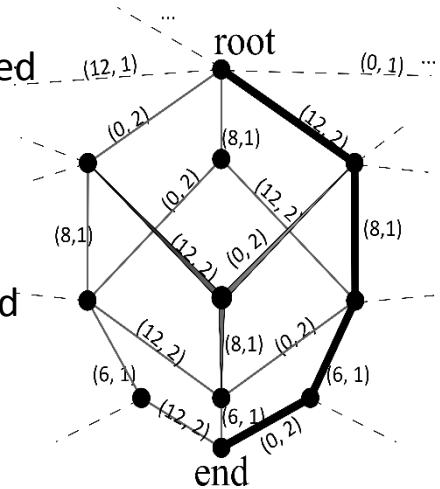
OBJECTIVES

- Develop a Model of Rhythm Syncopation

RESULTS/CONCLUSION

- Automatic Rhythm Generation
- rhythmic similarity / complexity measures

- Syncopation relates to music tension, complexity and groove
- No formalized model of syncopation existed previously
- THE MODEL: simple transformations based on music cognition principles
- Rhythmic patterns are organized in hierarchical tree structures



IMPROVING THE PERFORMANCE EVALUATION OF MOBILE WIRELESS NETWORKS USING NS-3

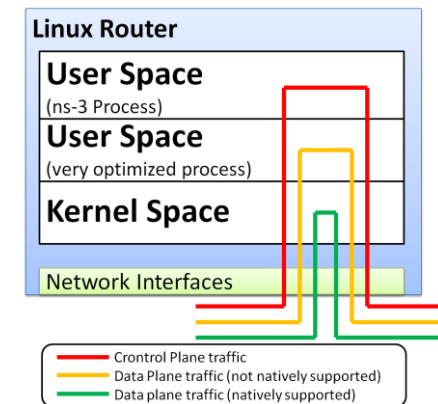
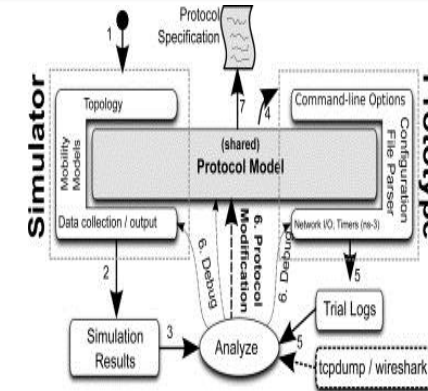
OBJECTIVES

- Simulation -> Prototype
 - Reuse ns-3 Protocol Models
 - Improve link compatibility
 - Reduce CPU overhead
- Prototype -> Simulation
 - Reproduce prototype conditions in simulation
 - Repeatable and realistic experiments
 - concurrent access

RESULTS/CONCLUSION

- Shared ns-3 protocol model successfully used in SITMe testbed
- Data-plane throughput successfully increased > 10x
- Realistic and Credible results from Simulations based on Prototype's real conditions

- In networking research and development, a recurring problem is the **duplication of effort** to write first **simulation**, and then **implementation code**, which can delay the process and introduce errors.
- We present the **Fast Prototyping methodology**, which allows **shared ns-3 Protocol Models** to be used in Prototypes via ns-3 emulation. **Data-plane** operations are also optimized, allowing to achieve a **throughput** more than **10x greater** than previously possible using ns-3 emulation.
- We also present the mechanisms to **record key variables** that characterize the **Prototype**, and then to easily **reproduce** those conditions **in simulation**. These **realistic simulations** allow to perform **further protocol tests and fine-tuning**.



3D RECONSTRUCTION METHODS FOR BREAST SURGERY PLANNING

OBJECTIVES

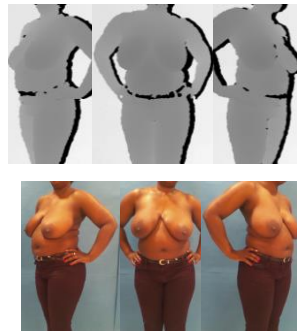
- Accurate 3D Reconstruction Method Acquired with Inexpensive Devices
- Mathematical Parametric Model to Describe Breast Shape

RESULTS/CONCLUSION

- A Planning Tool for Breast Conservative Cancer Surgery

- Registration Using Microsoft Kinect

Data Acquisition



Model Registration

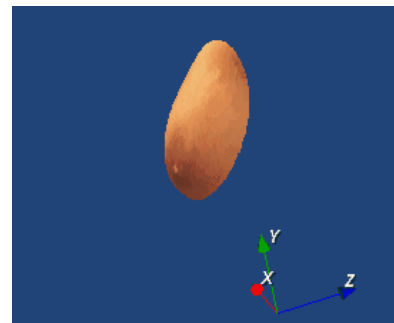


Segmentation

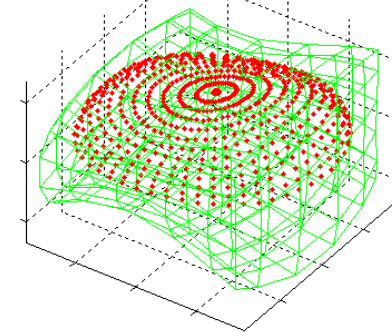


- Parametric Modelling

Customized Planning



Free Form Deformation



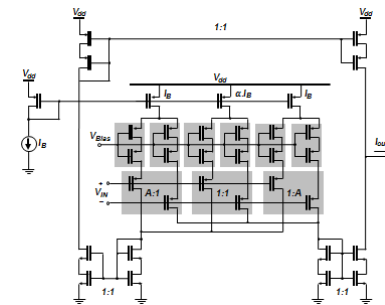
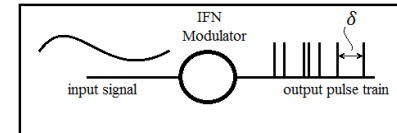
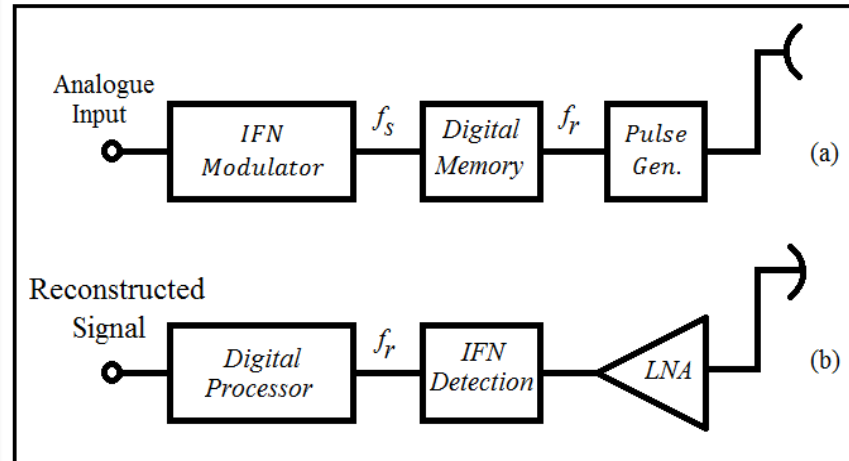
DESIGN OF A UWB TRANSMITTER USING INTEGRATE-AND-FIRE MODULATION FOR SENSOR APPLICATIONS

OBJECTIVES

- To relax the need for the power hungry Analog-to-Digital Converter (ADC) in Tx
- To increase the power efficiency of the UWB transmitters and realise the idea of self-autonomous sensors

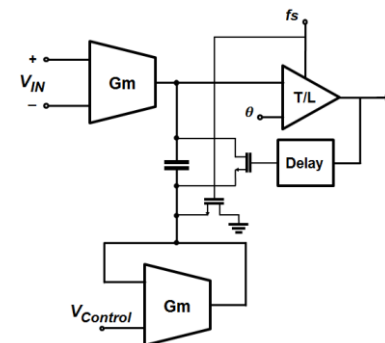
RESULTS/CONCLUSION

- Mathematical proof
- Designed an ultra low power analog integrator circuit with bandwidth of 0.1Hz to 700Hz
- Designed a UWB pulse generator
- Publications: 5



Note:

1. We are inspired by Integrate-and-Fire Neurons (IFN) to modulate data and send the sensor data through UWB regime.
2. The output signal of IFN modulator will be stored in a memory.
3. The data is sampled by a certain rate like f_s ; however it will be sent using a UWB pulse generator with a faster speed like f_r .



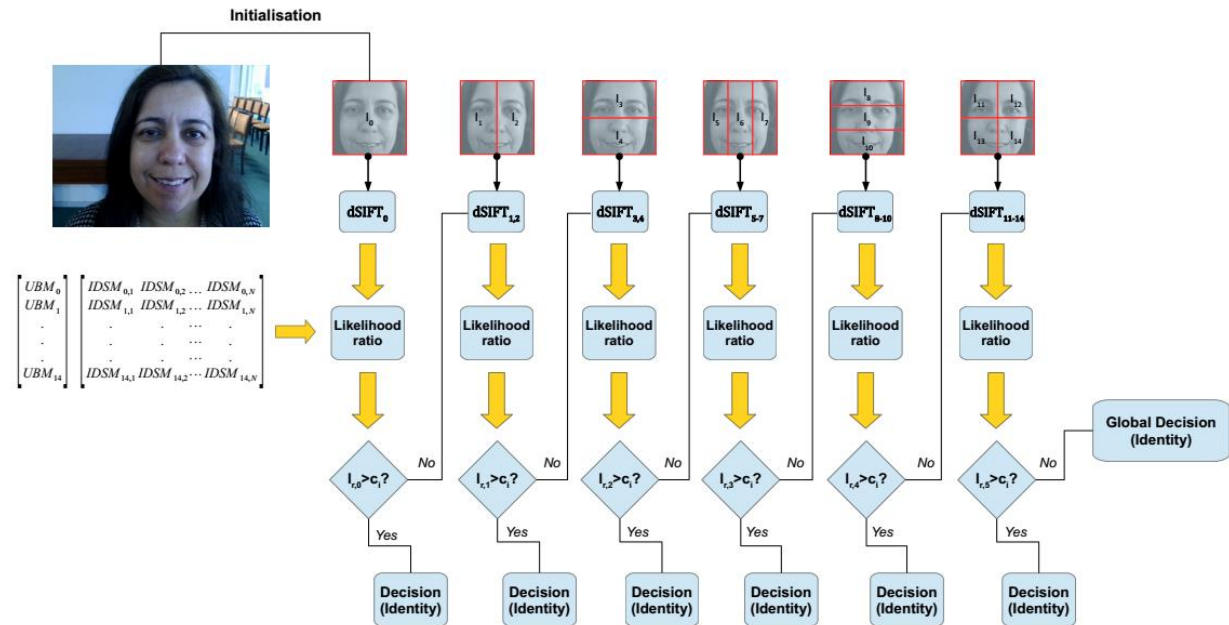
MULTIMODAL BIOMETRICS UNDER UNCONSTRAINED SETTINGS

OBJECTIVES

- Explore and develop new strategies to information fusion in biometrics.
- Adapt biometric recognition systems to portable device applications.
- Explore the synergy of multiple biometric traits.

RESULTS/CONCLUSION

- Periocular recognition ~90% in mobile scenarios;
- Face/fingerprint prototype;
- Hierarchical framework for face recognition in partially occluded environments;



Hierarchical framework for face recognition based on the biological mechanisms of face cognition by the human brain. Global information (i.e. Full face) gains priority over more detailed partial face representations.

AD-HOC NETWORKING APPROACH FOR EFFICIENT AND RELIABLE INTER-UAV COMMUNICATIONS

OBJECTIVES

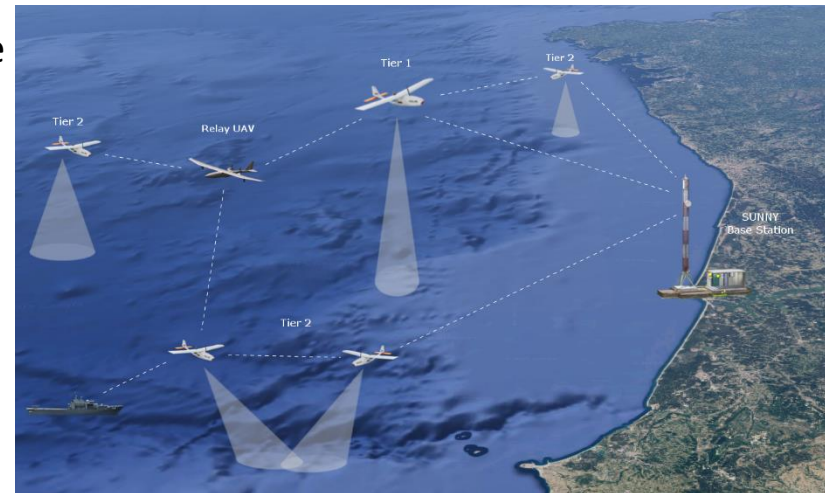
- Design a routing solution for UAV networks
- Design a topology control mechanism
- Evaluate using simulations and experimental setup

RESULTS/CONCLUSION

- Reliable communication solution for highly dynamic UAV Ad-Hoc Networks

- Unmanned Aerial Vehicles (UAVs) are used in missions of border surveillance, warfare, and monitoring, but in single mode
- With the development of smaller and low-cost UAVs, and suitable control algorithms, UAV swarms are gaining momentum
- UAV swarms critically depend on inter-UAV communications, but existing networking solutions have not been designed with this type of scenarios in mind

- High mobility degree of the nodes
- Frequent and rapid changes in topology
- Longer distances between nodes
- Different types of data to transmit



CERVICAL CANCER DETECTION USING COLPOSCOPIC IMAGES

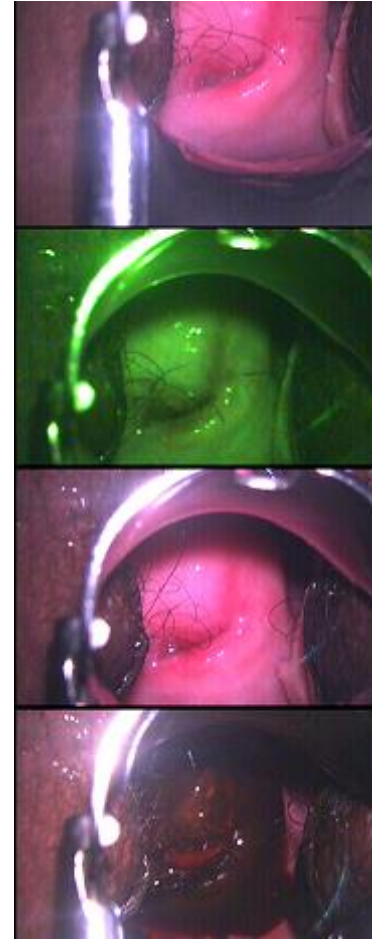
OBJECTIVES

- Computer-Aided Diagnosis system to optimize colposcopic assessment.
- Automatic detection of cervical lesions in digital colposcopies.

RESULTS/CONCLUSION

- Robust and accurate temporal segmentation of colposcopies using KNN and Weighted Finite Automata.
- CAD system to improve visualization of digital colposcopies.

- Colposcopic assessment, as suggested by the World Health Organization, covers four differentiated steps. Previous works focused on one of them.
- Automatic detection of cervical lesions in the four stages of the protocol.
- Spatiotemporal segmentation of the cervix region.
- Image registration methods able to overcome differences due to the protocol stage.
- **Extra goal:** Incorporation of other sources of data into the diagnosis mechanism (e.g. risk factors, biopsies, etc).



RECONFIGURABLE FPGA-BASED NC-OFDM PROCESSOR FOR MULTIMODE SPECTRUM AGGREGATION

OBJECTIVES

- Design of a **multimode NC-OFDM Processing Engine**;
- Exploration of efficient and high-performance **Dynamic Partial Reconfiguration (DPR)** methodologies for FPGAs

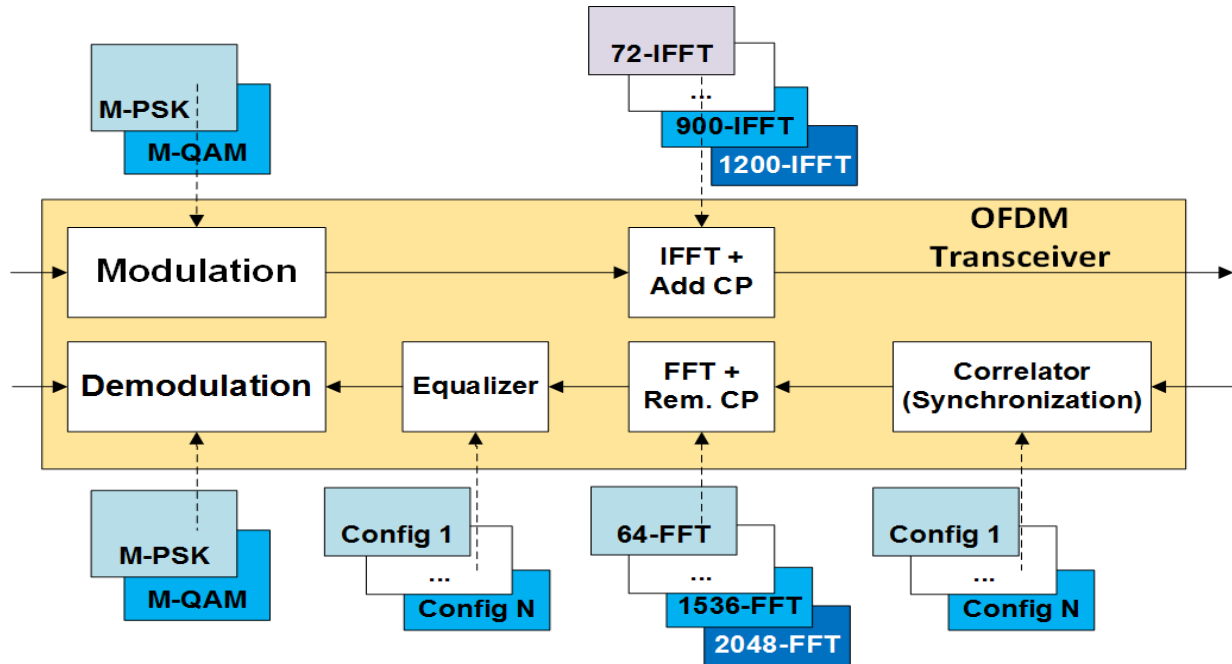
RESULTS/CONCLUSION

SotA aimed advancements:

- Innovative NC-OFDM engine architectures;
- CR transceivers reactivity improvement and reconfiguration times reduction.

Motivation: Design of fully adaptable radio transceivers through the use of all digital transmitters and receivers for multi-carrier, multi-standard communications (IEEE 802.11, IEEE 802.16, LTE – 3GPP, etc.), which will imply spectrum sharing for energy efficiency.

Keywords: Cognitive Radio, NC-OFDM engine, FPGA, DPR



TOWARDS MITIGATING UNWANTED CALLS IN VoIP NETWORK

OBJECTIVES

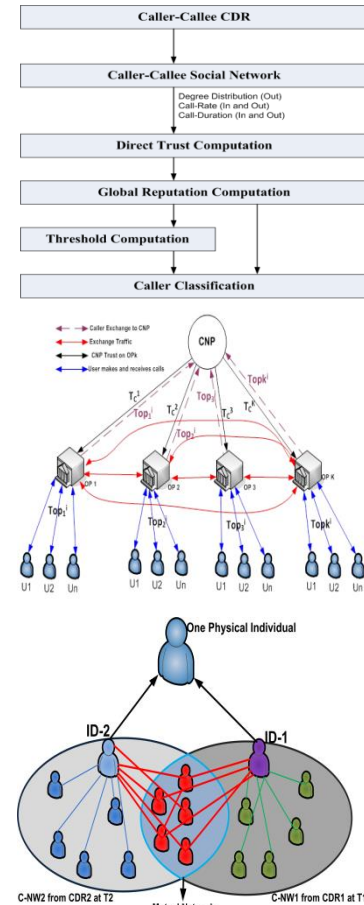
- Develop a Spam detection system for VoIP network using social network features and collaboration.
- Identity Linking for identifying persons having more than one calling identity.

RESULTS/CONCLUSION

- Stand-alone System achieves better performance but prolong detection time.
- Identity linking and Collaboration minimizes Detection time.

My Major Contributions are :

- Service Provider Level VoIP Spam Detection (Social Network Based).
- Collaboration among Service Providers for Improved Detection Time (Collaborative Approach).
- Identity Linking to Identify Users having more than one Identity for collective Reputation (Social Network and Calling Behavior Based).
- Procedure for Synthetic Data-Set (Various Graph Networks).



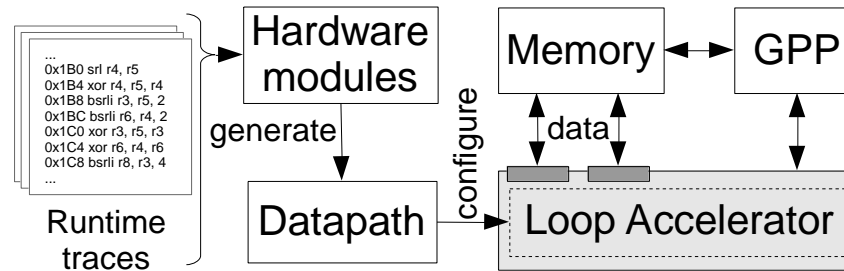
TRANSPARENT PROGRAM ACCELERATION WITH CUSTOMIZED CO-PROCESSORS

OBJECTIVES

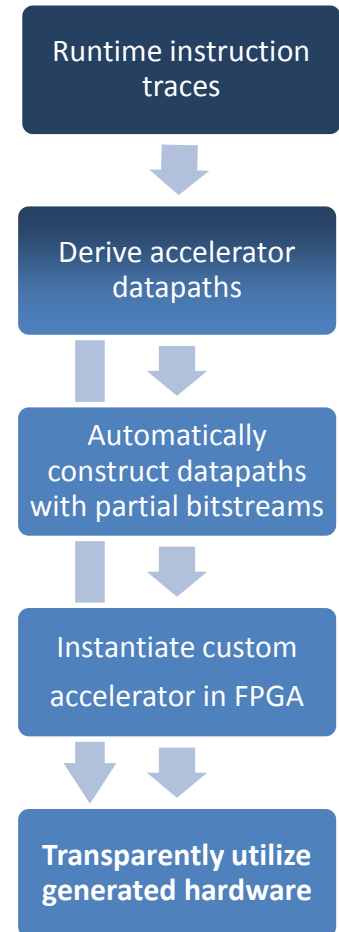
- Develop an embedded system for transparent binary acceleration
- Transforming runtime instruction traces into accelerator hardware
- Construct hardware accelerators at runtime using partial bitstreams

RESULTS

- Loop accelerator architecture and loop scheduler
- Geo. mean speedup of **7.28x** for **12 floating-point loops**



- Acceleration of data-oriented embedded applications.
- Execution → instruction traces → data graphs
 - Instruction parallelism
- Custom accelerators generated automatically by combination of partial bitstreams
- **Hardware acceleration without modifying source code or manual hardware design**



ANTENNA DESIGN FOR SPECIFIC APPLICATIONS

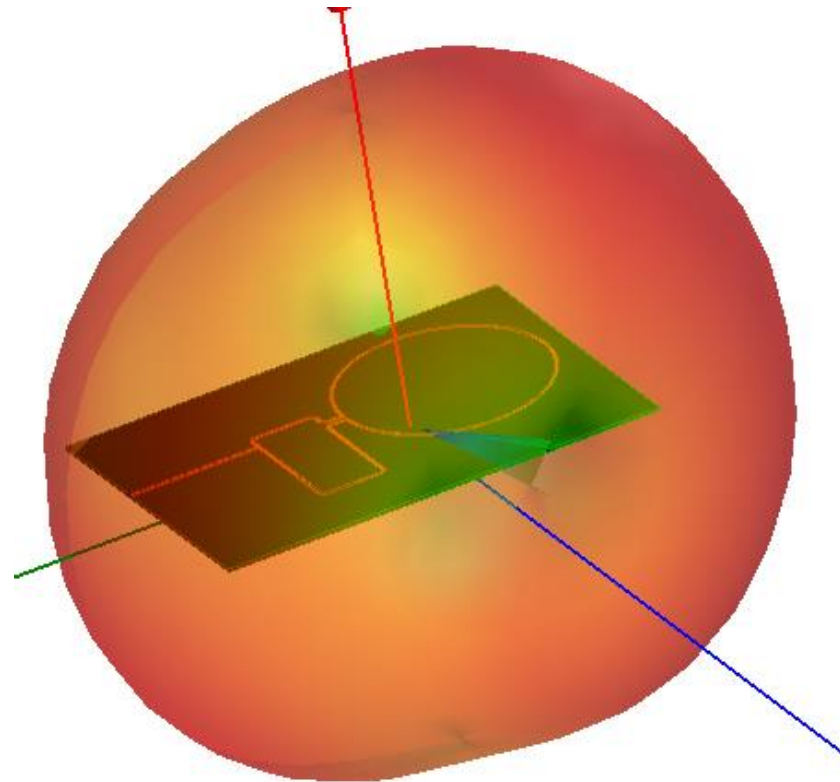
OBJECTIVES

- To design antenna for various applications such as:
 - Underwater radio,
 - TV white spaces,
 - Maritime communications to fishing ships.

RESULTS/CONCLUSION

- Better performance for the specified applications,
- Prototype construction and testing underway.

Loop antenna is one of such antennas that has been designed.



MISTRUSTFUL P2P FILE SHARING

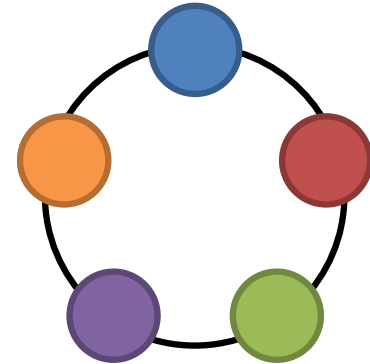
OBJECTIVES

- **Prevent user profiling, and avoid proof of content possession** when sharing files on **untrustworthy scenarios**
- Anyone can access
- User defined privacy level

RESULTS/CONCLUSION

- Novel privacy-preserving P2P file sharing scheme
- Rateless MDS erasure code
- Faster ns-3 simulation using CIDR-based network topologies

- Untrustworthy Scenarios
 - No trust is assumed on contents, network provider(s) or peers
 - Nodes may collude to compromise user's privacy
- Blocks downloaded and missing are not disclosed
- All contents are delay tolerant (no real time or streaming)

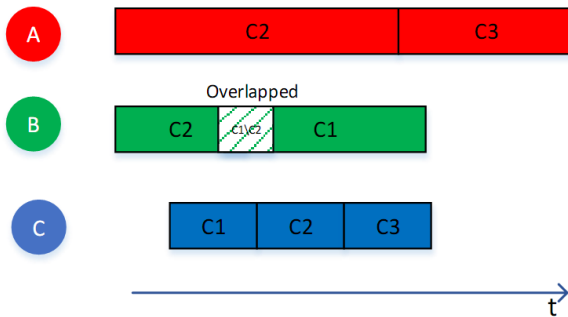


LEARNING IN EVOLVING VIDEO STREAMS

OBJECTIVES

- **Adoption of machine learning algorithms**
 - characterize and design robust recognition systems under evolving video streams
- **Identification and tracking of the visual objects**
- **Mathematical analysis of different learning methods**
- **Assessment the performance of various learning algorithms**

RESULTS/CONCLUSION



Semi-supervised incremental learning algorithm

- Ensemble-based approaches
- Incremental models

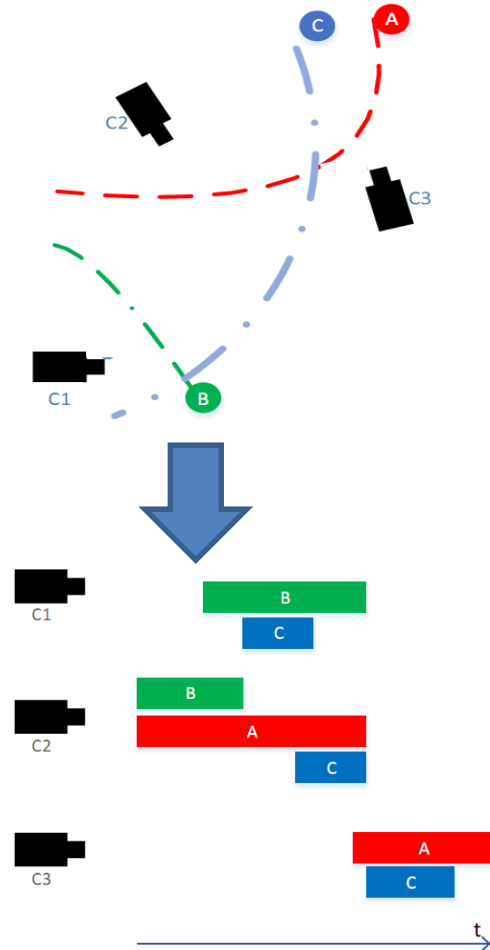
The framework asks the operator to label meticulously chosen batches.

The system can address many practical problems in an evolving multicamera scenario, such as concept drift, class evolution and various length of video streams.

Robust models

- Effect of existing robust descriptors
- Perceptual models

The system needs to address viewpoint changes, illumination variation, deformation, and Occlusion.



UTILIZING BEAMFORMING ANTENNAS FOR IMPROVING THE PERFORMANCE OF MOBILE WIRELESS MESH NETWORKS

OBJECTIVES

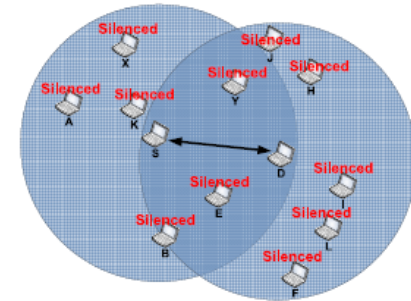
- i. Studying the performance of WMNs (throughput/ delay/ fairness) and improve it using **directional antenna**
- ii. Improve (i) → **mobile** WMNs
- iii. Improve (ii) → **multi-radio** mobile WMNs

RESULTS/CONCLUSION

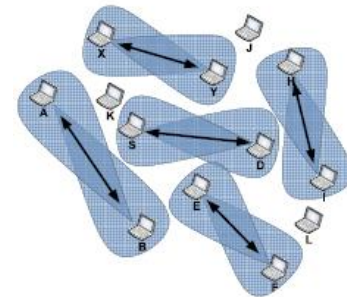
- Average throughput of a WMN can increase about **56%** and the average network delay can be reduced by approximately **40%**, without compromising fairness.

Background

- Wireless Mesh Networks (WMNs)
 - Consist nodes which can setup dynamically
 - Defined by IEEE 802.11s standard
- Omnidirectional Antenna
 - the only antenna considered by IEEE802.11s
 - saturation in larger or denser scenario
- Proposing Directional Antenna – **Motivation?**
 - Gain of Directional Antenna
 - multi small hop → single long hop transmissions, low delay
 - Interference Reduction Capability
 - avoid interference from unwanted directions, increases SNR
 - Utilization of Network
 - Increased capacity, more users



(a) Omnidirectional Antenna



(b) Directional Antenna

OPTIMIZATION OF RELAY NODE PLACEMENT IN WIRELESS UNDERGROUND NETWORKS

OBJECTIVES

- Study optimization techniques
- Design novel relay node placement algorithm for WUN
- Develop ns-3 based simulation framework for WUN

RESULTS/CONCLUSION

- ns-3 based WUN simulator
- Novel relay node placement algorithm for WUN

• Motivation

- WUN with several applications: Agriculture, Security, Infrastructure monitoring
- Underground radio comms very different and unstable compared to over the air comms
- Lack of design and simulation tools for WUN

• Methodology

- Formulate relay placement problem as optimization problem
- Identify and study suitable optimization techniques for relay node placement
- Develop novel algorithm to achieve optimal relay node placement in WUN

