ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

School of Computer and Communication Sciences

LCA

A. El Fawal, K. Salamatian, D. Cavin, Y. Sasson and JY. Le Boudec

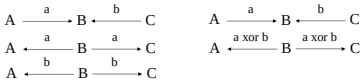
A framework for network coding in challenged wireless network

Objectives

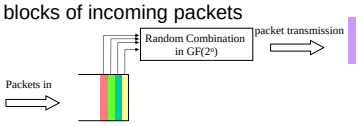
To develop a software and system framework for implementing ***network coding*** based forwarding mechanisms for challenged networking conditions. The software framework has to be portable, flexible and generic.

1- What is network coding ?

- New paradigm that subsumes routing
  - Well suited for application layer forwarding and wireless networking
  - Using the intrinsic broadcast property of wireless networks
- Example:
  - A and C talk via B used as relay; transmission is of broadcast type because we are using a wireless LAN:



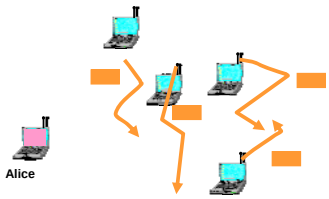
  - Network coding sends a combination of received messages instead of repeating them
- How does it works
  - A node makes a random linear combination of blocks of incoming packets



  - With high probability, destination can recover *n* packets out of *n* linear combinations
    - *no coordination needed !*

2- Why is Network Coding Well Suited for Opportunistic Networking ?

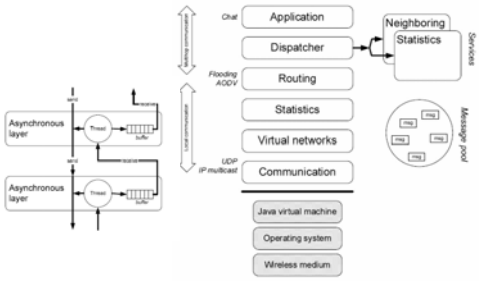
- It can significantly improve probability of delivery in a spontaneous network
  - "ball in a bin" phenomenon: time to get all messages in a random environment is O(*n*) with network coding*O(n log(n)*) with flooding
- Reduce the redundant packets in random, non coordinated, non permanent networks



- Alice leaves the room. New messages are appended during her absence. Alice returns to room and gets info back without coordination from peers

3- Franc Framework

- JAVA based
- Based on a layered architecture



  - Use message pool to reduce garbage collector use
  - Configuration defined through an XML file
  - Full integration with JIST/Swans simulator

4- Achievements

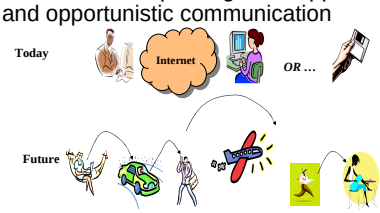
- We have developed a layer in the FRANC framework that implements network coding
- This layer make possible to easily port application to network coding based forwarding paradigm
- The ability of Franc of integration with JIST/SWANS enables the use of the same program for real execution and simulation
  - Only configuration files changes

5- Demonstration

- We implement a Distributed Bulletin Board
  - Messages sent by each participant is received by all participants.
- We assume that users could join or leave the BBN every time they want.
  - A user coming in the middle of the communication will catch up the message sent when he was off.
- No synchronization between user is needed to join the session.
- Simulation will be shown using two approaches
  - Topology simulated through Emstar simulation environment
  - Full network simulated through JIST/SWANS
- We show that network coding works without any configuration and need fewer redundant packets that flooding (ratio is 2 to 3)
- The full implementation is available under GNU licence for download at http://icawww1.epfl.ch/tmp/NCcode.zip

6- Haggle project

- The world is NOT always connected !
  - Users move between heterogeneous connectivity islands
- End-to-end is not always possible, one or both ends may be disconnected
  - Haggle Project
- Exploring networking for mobile users using local P2P wireless connections as well as infrastructure based Internet access
- Exploiting User Mobility
- Pocket Switched Networks, a new communication paradigm to support ad-hoc and opportunistic communication



6- Implementation details

- Implementation using GF(2^8) arithmetic's
  - Fast multiplication using discrete logarithm table
- A Network Coding header is added
  - Contains list of combined packets and coefficient use to make the packet
    - Risk of packet size explosion
- Linear equation resolution implemented as gaussian elimination
  - Risk of curse of dimensionality