

# LightPeers: A Lightweight Mobile P2P Platform

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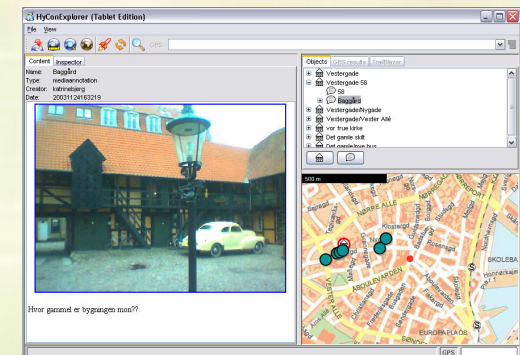


# Plan

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  - Approach
- The LightPeers Framework
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  - Protocols: discovery, session management, robust delivery
- Prototype implementations
  - Applications: chat, sketch, file share, vote
- Evaluation
- Future Work & Wrap up

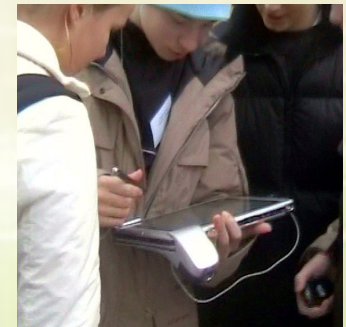
# Motivation - scenario

- The usage scenario relates to an earlier research project (iSchool), where project oriented learning for pupils in public schools was investigated and supported.
- We used the term Nomadic Learning for the type of learning where pupils are divided into project groups, sent out to gather information about their project, and then presenting the result for their fellow pupils.
- To support this we made an advanced hypermedia system based on our own HyCon framework, where information could be produced, structured, annotated, and presented, through various devices (laptops, tablets, PDAs, and mobiles).
- Thus supporting linking between the physical and digital worlds, and organising material by sensoring the physical context (metadata).



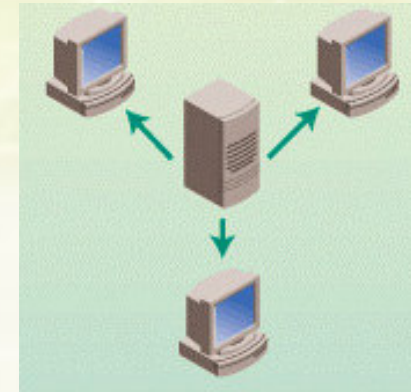
# Motivation – user model

- We made a suite of HyCon kits to gather information, where the most popular were the tablet PC and mobile phone versions.
- In project groups of 4-5 each of the pupils would typically have their own device. E.g., one group member could have a tablet PC with a large screen, but clumsy form factor, and the rest could have mobiles.
- Shortcomings:
  - The HyCon architecture was designed around a central server! Thus, all information was sent through the server.
  - The mobile HyCon kits utilised cumbersome internet connections (often GPRS). So, e.g., a picture taken by one group member with a mobile, was not easily shared with another member having a tablet PC for a better view at the picture.

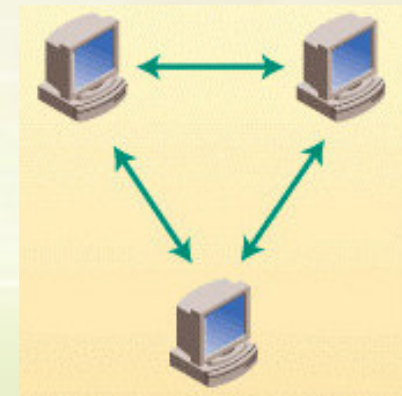


# Motivation - approach

- The approach to overcome this was to use a *lightweight* P2P toolkit for facilitating, group members to be able to share information directly! And to share other resources like storage, sensor data, internet connection, and more.
- Existing systems for mobile P2P were found, but were a bit too overwhelming for constrained devices like mobile phones, e.g.:
  - JXME2 (acting through a JXTA proxy)
  - Proem (Java based engine running Peerlets)



Centralistic HyCon architecture



P2P architecture

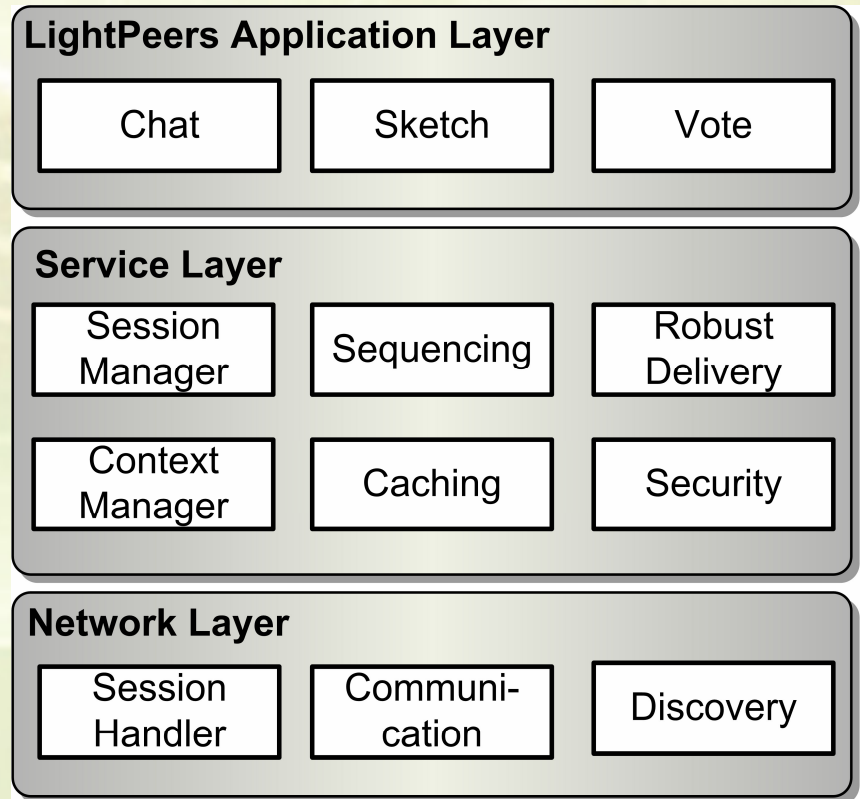


# The LightPeers Framework

- The usage requirements for a mobile P2P framework for limited devices based on our findings were:
  - **Lightweight:** the framework should be designed minimal/lightweight to be able to run on even limited devices, easy to implement, and a simple conceptual model.
  - **Interoperable:** LightPeers should support interoperability by including definitions of protocols and message formats.
  - **Support for an ad hoc network topology:** Peers/pupils coming in and out of network range, but still have a grouping/session mechanism.
  - **Support delay tolerant messaging:** Peers/pupils coming in and out of network range should still receive all messages.
  - **Go beyond the simulator.** ☺

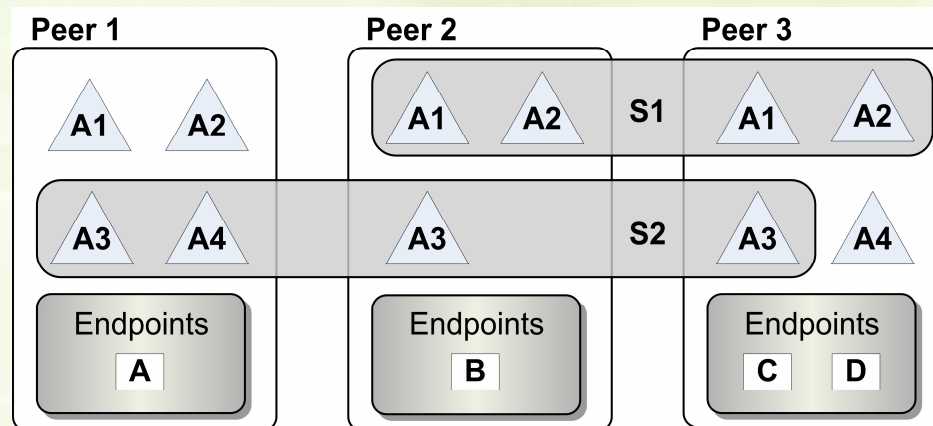
# The LightPeers Architecture

- LightPeers is a framework to be used for various applications not only one. (Application Layer)
- Robust message delivery based on multicast among peers in the same group where messages survive if a peer is outside network coverage. (Service Layer)
- Continuous discovery of peers allowing ad hoc networking on top of UDP. (Network layer)



# Architecture: conceptual model

- The user model for LightPeers is based on an educational setting with project groups of 4-5 pupils gathering, constructing, and sharing digital material in the field.
  - A peer in LightPeers is a person/pupil logged in on a LightPeers enabled device.
  - A session is a number of peers, registered applications, and shared digital material.



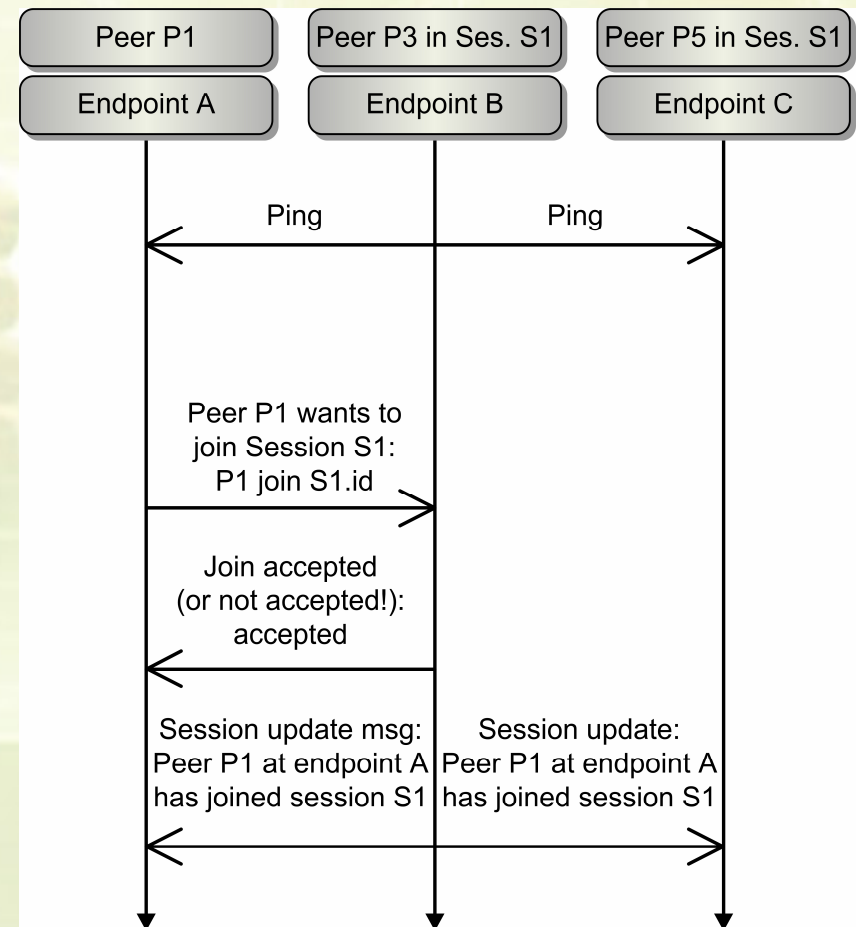


# Protocols – Ping/Sync

- The Discovery component in the Network layer continuously broadcasts ping packets and receives ping packets from other peers nearby.
- The Ping packet includes:
  - IDs on the sessions the peer is participating in to advertise which sessions are available on this peer, and
  - the latest sequence number of packets sent from the peer in each session, which is used for syncing purposes for other peers in the same session.

# Protocols – Session Management

- The session is a key concept as all application data is shared within sessions.
  - Any peer can create a new session, but
  - a peer has to be approved to join an existing session by a session member.
  - Session updates is send to session peers when a change in the session state occurs.

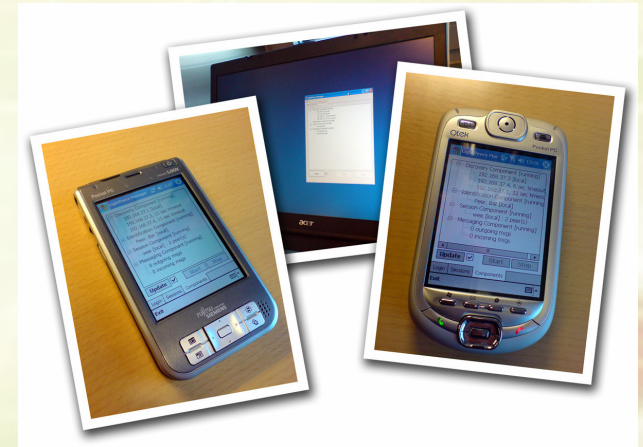


# Protocols – Robust Delivery

- Application data is always sent through a sessioncast which is realized by epidemic dissemination among session peers.
- Optional sessioncast features:
  - Sequencing: every packet is stamped with a seq # making it unique (session id, peer id, seq #).
  - Caching: incoming and outgoing packets are cached.
  - Robust Delivery: ensures that packets are delivered to the application in sequence on the receiving peers. If a packet is missing a resend packet request is made to the sending peer.
- The seq # provided through the Ping packet is used by Robust Delivery as an “end of seq” marker.

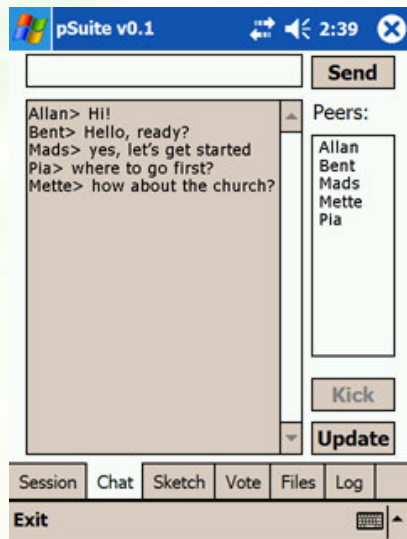
# LightPeers - Implementation

- The reference implementation is developed on the Mono/.NET CF 2.0 in C#. The hardware platform used is the Fujitsu Siemens Pocket LOOX 720 using its WLAN card.
- Support for more devices is in progress:
  - We are at the moment working on an implementation for the GumStix hardware and Linux software setup, and
  - The Nokia N80 WiFi enabled mobile phone is also being tested at the moment.

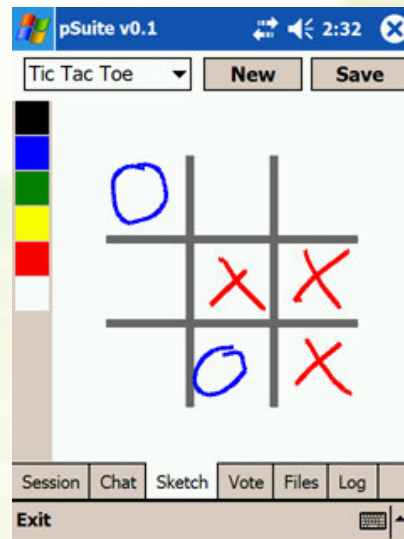


# LightPeers Applications

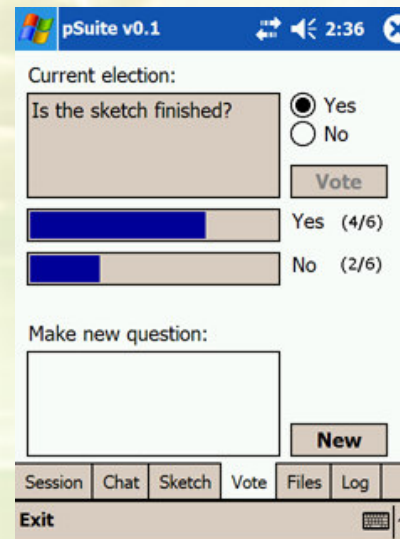
- LightPeers is been tested with the following applications supporting mobile communication, play, sharing and decision making:



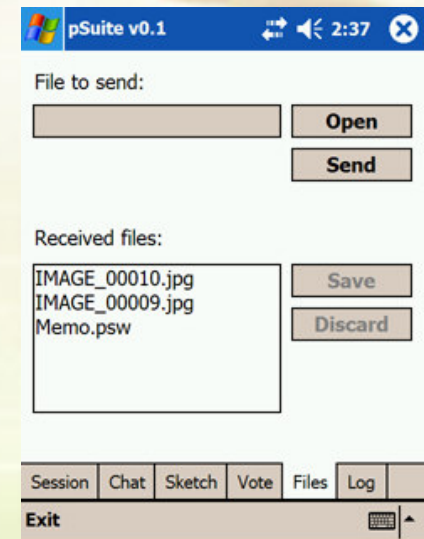
Chat



Sketch



Vote

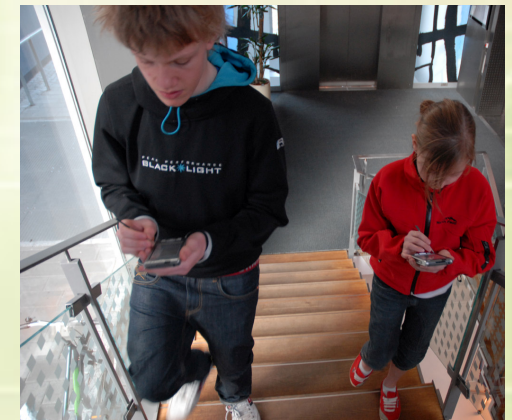


File Share



# Evaluation

- We have conducted qualitative usability tests of the LightPeers framework and applications with pupils testing the support of Nomadic Learning by:
  - group/session forming,
  - constructing and sharing digital material, and
  - decision making.
  - While being in network range and out of range and joining up.
- The evaluations resulted in suggestions for improvements of the applications, but also showed that LightPeers supported the basic Nomadic Learning scenarios.



## *Future work*

- Ahead of us is also to evaluate how the framework facilitates application development, and
- a series of quantitative technical performance tests: average time of discovery and throughput of data over several hops for a given hardware configuration, scalability of sessions, ...
- Implement support for Secure Sessions by the Security protocol feature! (Private/Public key, shared Session key)
- Support more devices, e.g., the N80 by porting LightPeers to Python.

# Wrap up

- The development of LightPeers has been driving by the usage scenarios of Nomadic Learning for pupils in public schools.
- Main contributions from LightPeers:
  - Support for Nomadic learning:
    - self-moderating peer groups
    - collaborative construction, sharing and gathering of digital material
    - decision making in peer groups.
  - Design of a Minimal mobile P2P framework:
    - A Robust Delivery protocol designed for a dynamic network topology.
- Please download and try out LightPeers from:

<http://www.daimi.au.dk/~bentor/LightPeers/>