Content Delivery in

Ad Hoc Wireless Networks

Project Plan

Dec 10-03

Client:

Iowa State University

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Table of Contents

List of Figures

List of Definitions

Wireless Ad-hoc Network: A decentralized wireless network which does not depend on preexisting infrastructure like routers but each node participates in data transmission.[1]

USRP/USRP2 (Universal Software Radio Peripheral): USRP/USRP2 is a general purpose RF hardware device designed by Ettus Research which provides a low-cost, readily but versatile radio functionality.

GNU Radio: GNU Radio is an open-source software development toolkit for the development of software-defined radios. It contains a variety of signal processing algorithms that we will use on the data collected by the USRP hardware.

P2P (Peer to Peer): A system where the users both supply and consume the data available on the network.

SD Card (Secure Data Card): A non-volatile memory card which would be used to store programming for the USRP2 in its standalone operation mode.

Executive Summary

As the understanding of the world around evolves and grows, the control and distribution of information is key to the continual growth and progress of society. Previous exchanges of information required physically receiving the information from the source, receiving it from a third party, or from large network sources such as the internet. These previous methods were not conducive to real time sharing of information between individuals. Our project will allow users to stream data onto the network for others to view immediately and straight from the sources of the information.

A team of three Iowa State University College of Engineering students will work to create an ad Hoc wireless network which will allow the ability of users to stream information using P2P traffic. Our group will implement this network with several USRP and USRP2 radios, wireless sensors, and the GNU Radio protocol.

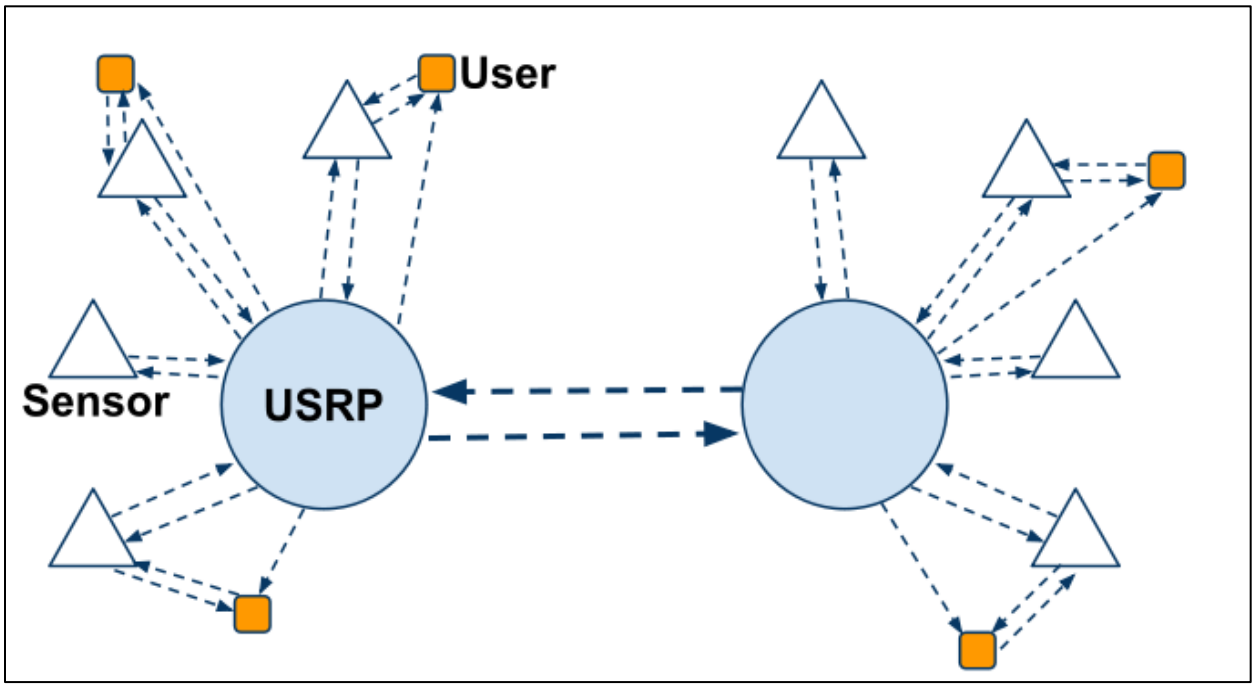
Acknowledgement:

Our group would like to thank Iowa State University for providing the equipment needed for the project including the USRPs, USRP accessories, and laptops used to complete this project. We would also like to thank our faculty advisor Professor Lei Ying and his PhD student Ming Ouyang for answering our questions about the project and helping troubleshoot the errors that we have and will encounter.

Problem Statement:

Wireless connectivity has become popular in our everyday life and the ability to exchange information is increasing just as fast. Examples of technologies implementing ad-hoc networks include Wi-Fi, Bluetooth and Zigbee.

In this project we will be developing our own content delivery protocols for an ad hoc wireless network. Our team will be responsible to design and implement protocol-stacks (from physical layer to application layer) on the software defined radio platform using GNU radio software and USRP/USRP2 hardware. Utilizing software defined radio significantly lowers the barrier of wireless system design by moving the design from hardware to software.



Operating Environment:

The network will be providing our P2P streaming service for an individual building with the users accessing the network also inside the building. Because our system will be operating indoors to provide network coverage for the entire building we won't have to worry about external weather conditions affecting the equipment or the transmission of the data. Since our network will be operating indoors, the network will need to overcome the many stationary physical path obstacles as well as smaller moving path obstacles. Future projects may be implemented to provide an outdoor network and will need to provide physical protection from temperature, rain, dust, weather conditions, wildlife, and vandalism. Moving the network outside will also require compensating the data signal for adverse weather conditions to improve reliability.

Intended User	Intended Use
Non-technical unknowledgeable peripheral device user	Taking video and wirelessly broadcasting it to other users around the area who can see it in real time. Should not require any knowledge of how background network works, user only has to start filming and hit a "broadcast" button and it should broadcast the video to all users from there until the user ends filming.
Administrator	Manage feeds on the network, limiting and/or cutting the connectivity of ones that become too much of a hindrance to the network.
Commercial user	Broadcast of meeting or demonstration from on-site area to an office building or safe-zone.
Educational user	Broadcast of period of instruction by a professor to students in his/her class

Assumptions

- *Minimum user access:* The system works only when there is at least one user who is broadcasting and at least one user streaming the data.
- *Users within the range of sensors:* Users will be able to get best reception when they are in the range of about 100 feet from the sensory/ USRP network.
- *USRP and Laptop in same location:* The USRP does computations when it is connected to a laptop and will not function as a stand-alone system. The USRP2 does allow the use of an SD card instead of an external laptop for computation. However, using the SD card reduces the number and complexity of computations available to the USRP2.
- *Indoor Network:* The USRP and sensors will be placed indoors so physical protection from weather elements will not be needed. We also will have to compensate for signal degradation due to walls and reflections.

Limitations

- The equipment is not built to operate in extreme temperatures and should be kept indoors.
- USRP 2 is a stand-alone system but can do limited computations. However, a laptop working with USRP ensures full functionality.

Expected End Product and Other Deliverables

The end product delivered will be

- *Fully Functional network*

The network, which is capable of communicating with all the USRPs, sensors, and capable of delivering content to users will be delivered at the completion of the project.

Other Deliverables include

- *Project Plan Document*

The project plan document highlighting the proposed approach plan will be provided at the completion of the project

- *Design Document*

The design document highlighting the design approach considered for the project will be provided at the completion of the project.

- *Design Review Presentation*

The presentation made for the design review will be provided at the completion of the project

- *Project Poster*

The poster designed highlighting our achievements for the project will be provided at the completion of the project

- *User Guide*

A user manual will be provided to the user upon completion of the project in order to act as a reference on how each element of the system works. This document will include a software guide as well as instruction sets that assist with training and reference material.

Functional Requirements

- *Video streaming to peripheral users at 10fps*
    - A fully functional system must be capable of providing a bitrate that allows 10fps of streaming to peripheral users.
- *Simultaneous Streaming*
    - The fully functional system must be capable of supporting 10 simultaneous streams at any instant of time.
- *Minimum data rate at all time*
    - Our team plans to provide a minimum data rate at all time for streaming the broadcasted data. This minimizes the lag in the real-time video when streamed.
- *Maximum bandwidth utilization*
    - The system is limited to a bandwidth of 8MHz for the USRP and 20MHz for the USRP2.
- *Broadcasting range*
    - The system must be able to provide good reception for users within 100 feet of the USRP/sensors indoors.

Non- Functional Requirements

- *Physical Dimensions*
    - The dimensions of the sensors need will need to be small enough to be implemented in classrooms and labs without needing to change any layout of the room. The dimension of the USRP is fixed.

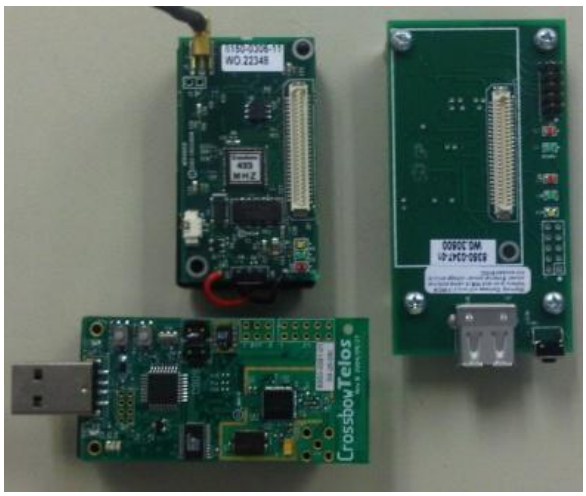
- *Equipment Protection*
    - The equipment is placed indoors at all times and does not require weather protection.
- *Power Requirements*
    - The USRP and the USRP2 need an AC to DC converter. The sensors will need 2 AA batteries to supply power or solar sensors that will convert light from interior light sources into energy used by the sensor.

Technology Considerations

- *GNU Radio:* GNU Radio is an open-source software development toolkit which enables a variety of signal processing on the data collected by the USRP hardware. GNU radio is a software interface to the USRP. This technology is used for wireless link between electronic systems

- USRP/USRP2: The USRP/USRP2 is a general purpose Radio Frequency hardware device which provides a low-cost, readily but versatile radio functionality. It runs on the GNU radio platform.

- *Sensors:* Our team is planning on implementing sensors made by Texas Instruments and Crossbow. Some of the sensors considered have USB connectivity, whereas, other sensors have wireless connectivity



Safety Considerations

- *Excessive exposure to radio frequency*
    - Being exposed to excessive radio frequency can lead to health hazards
- *No interference*
    - Equipment used for this project will not interfere with other radio devices which include wireless 2 way radios.

All the technology used here is purely for educational purposes and not for jamming other equipment or for destructive purposes.

Risks and Mitigation Plans

The project is designed with precision and quality; however, there are certain risks, which could be encountered during the course of project lifetime. The possible risks are indicated below:

- *Device/Sensor failure*
    - Sensors are prone to fail with increasing time and usage. To reduce the effect of sensor failing on the system, our team is planning to overlap sensors and make a mesh network. Taking this approach, we will be able to use other sensors to route the data temporarily, until the sensor is repaired/ replaced. The sensors we plan to use are commonly available and will be easy to order and replace.
- *Bad data transmission*
    - Bad data transmission can occur in a network when a broadcasting user is either out of the range of the USRP or the sensor. Our team plans to implement filters and other techniques to reduce and remove noise errors. Bad data transmission can also occur when any sensor or a device fails. Our plan of designing a mesh network mitigates this problem.

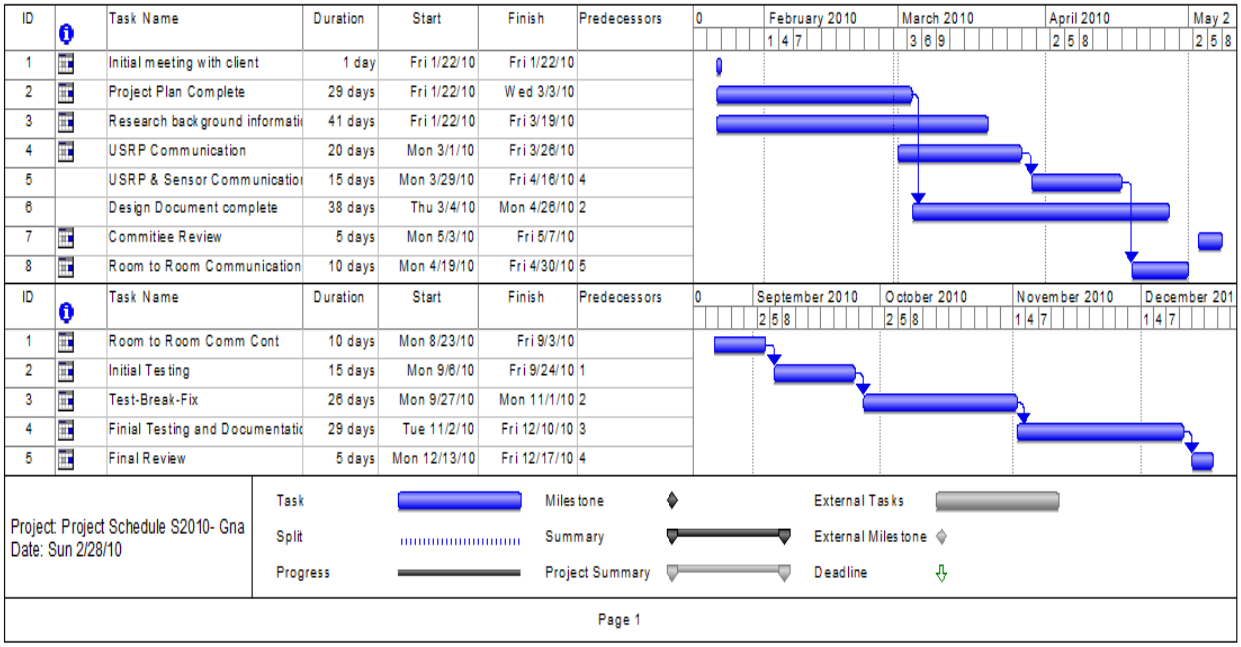
Project proposed milestones

- *March 3, 2010:* Project plan is due
- *March 26, 2010:* Communication between USRPs
- *April 16, 2010:* Communication between sensors and USRPs
- *April 26, 2010:* Design Document is due
- *Early May 2010:* Committee review
- *September 3, 2010:* Room to Room Communication
- *September 24, 2010:* Initial phase of Testing
- *October 2010:* Test-Break-Fix
- *November/ December 2010:* Final Testing and Documentation

Estimated Resources and Cost

Resource	Number of Units	Cost per Unit	Total
USRP (Base Kit)	2	$700	$1,400
USRP2 (Base Kit)	3	$1400	$4,200
RFX 2400 Transceiver daughterboard	5	$275	$1,375
VERT 2450 Antenna	5	$35	$175
Sensors	25 - 50	$100 - 200	$2500 – 10,000
Laptops	5	$800	$4,000
Work Hours	600	$20/Hour	$12,000
Total Cost			$25,650 – 33,150

Project Schedule:



ID	Task Name	Duration	Start	Finish	Predecessors
1	Initial meeting with client	1 day	Fri 1/22/10	Fri 1/22/10	
2	Project Plan Complete	29 days	Fri 1/22/10	Wed 3/3/10	
3	Research background informati	41 days	Fri 1/22/10	Fri 3/19/10	
4	USRP Communication	20 days	Mon 3/1/10	Fri 3/26/10	
5	USRP & Sensor Communicatio	15 days	Mon 3/29/10	Fri 4/16/10	4
6	Design Document complete	38 days	Thu 3/4/10	Mon 4/26/10	2
7	Commitiee Review	5 days	Mon 5/3/10	Fri 5/7/10	
8	Room to Room Communication	10 days	Mon 4/19/10	Fri 4/30/10	5

ID	Task Name	Duration	Start	Finish	Predecessors
1	Room to Room Comm Cont	10 days	Mon 8/23/10	Fri 9/3/10	
2	Initial Testing	15 days	Mon 9/6/10	Fri 9/24/10	1
3	Test-Break-Fix	26 days	Mon 9/27/10	Mon 11/1/10	2
4	Finial Testing and Documentatic	29 days	Tue 11/2/10	Fri 12/10/10	3
5	Final Review	5 days	Mon 12/13/10	Fri 12/17/10	4

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Closing Summary

In a world where the need of fast and reliable exchange of information is growing our network will showcase one possibility of how this can be achieved. Our network will rely on the flexibility of P2P sharing and combine it with the immediate gratification of streaming data. By streaming the data the users will not be required to wait to view the information they need as well and continue to propagate the data through the network.

References

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[6] "Peer-to-peer." *Wikipedia, the free encyclopedia*. Retrieved March 1, 2010 from the World Wide Web: <http://en.wikipedia.org/wiki/Peer-to-peer>.

[7] "Universal Software Radio Peripheral." *Wikipedia, the free encyclopedia*. Retrieved March 1, 2010 from the World Wide Web: <http://en.wikipedia.org/wiki/Universal_Software_Radio_Peripheral>.