FREQUENCY DISSEMINATED SCHEDULER FOR DIGITAL SPECTRUM NETWORKS

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ABSTRACT:

This paper proposes FlashLinQ a synchronous peer to peer wireless PHY/MAC architecture.FlashLinq is a synchronous Time division duplex(TDD)Orthogonal frequency-division multiple access (OFDMA) technology operating on dedicated licensed spectrum and is distinguished by its high discovery range. TDD OFDMA is a time division duplex of orthogonal frequency division multiple access.by using this we can transmit a data by searching a neighborhood area network where fixed and mobile peer application can be interacted directly without infrastructure. Flash- LinQis completely system architecture including : 1)timing and frequency ; 2)peer discovery; 3)link management; and 4)channel-aware distributed power, data rate, and link scheduling. FlashLinQ has been implemented for operation over licensed spectrum on a digital signal processor/field–programmablegate array (DSP/FPGA) platform . If any device connection problem occurs then it will wait for device enable .it stored it in a database and after enable it will transmit adata. such networks promise scalability and great performance improvement in utilizing scarce spectrum resources .It is used in the smart phones (I phones).

INTRODUCTION:

Flash-LinQis a *synchronous*(timeslotted)OFDM-basedsystem that enables node discovery,channel allocation, and link scheduling with power control.This system allows for an opportunistic ***fading-state-aware***schedule to be recomputed each time-slot (roughly 2 ms). Thekey technical innovation is to leverage the physics of propagationand parallel signaling enabled by OFDM to develop atone-matrix-based *analog* signaling scheme. Thismechanismencodes, within each tone, both the presence of a signal aswell as the signal strength. Leveraging this, the OFDM matrixenables the transmitters and receivers to sample the *potential interfering* links, thus enabling calculation of estimates ofsignal-to-interference (SIR)1 at each link (transmitter/receiver).

This, in turn, enables explicit link and rate scheduling, whereeach link that is scheduled for transmission optimizes its datarate to obtain an efficient spatial packing of links. With the proliferation of data services and smart phones (e.g., the iPhone), there has been a renewed interesting ad hoc wireless networks. Such networks promise scalability and other improvements in the utilization of scarce spectrum resources. This motivated the network modeling and algorithms community to develop cross-layer synchronous resource allocation mechanisms [2] that, in theory, promise significant gains.Wireless ad hoc network implementations and deployments, however, have focused predominantly on asynchronous CSMA/CA mechanisms and modifications there .This is partially due to the belief that both messaging (for channel state aware spatial coordination) and synchronization overheads will render synchronous cross-layer schemes impractical .

this paper describes a wireless system called flashlinq that by example ,demonstrate that we can design and implement a practical ,synchronous MAC and PHY architecture that can be support cross layer mechanism . FlashLinQ is a new OFDM-based synchronous

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architecture for MAC/PHY, that: 1) incorporates new *analog*signaling mechanisms for multinode distributed coordination; 2) enables distributed channel-aware spatial resource allocation and packing; 3) supportsQoS and fairness at multiple timescales. In coordination with cellular providers, from which FlashLinQ extracts fine-grained timing for network synchronization ,we have implemented FlashLinQ over a *licensed*spectrum on a digital signal processor (DSP) and field-programmable gate array (FPGA)-based platform to demonstrate its feasibility and the significant performance benefits that accrue.

This paper is based on the three overview :

1) technical overview

2) Hardware overview

3)deployment overview

Technical overview:

Thus, the new signaling mechanism addresses several key problems in spatial resource allocation: 1) orthogonality versus reuse (i.e., which links are allowed to simultaneously transmit and at what power levels and data rates); 2) channel-aware distributed scheduling (to account for fast/slow fading-based channel gain variations); 3) large dynamic range in signal strengths (enabling very long links, e.g., 250 m, to coexist in a "sea" of short links, e.g., 10 m); and 4) hidden/exposed nodes.

Hardware overview:

The FlashLinQ modem prototype is based on a general FPGA- and DSP-based platform that operates at a carrier frequency of 2.586 GHz using a bandwidth of 5 MHz. The time-domain sample-level processing and LDPC decoder are implemented in FPGA (Xilinx Virtex-4). The frequency-domain symbol-level processing is implemented in a TI TMSC64x DSP chip. The L2 functionalities, including packet disassembling and reassembling, fast ARQ, etc., are also implemented in the DSP. The DSP communicates with a Linux-based host machine via Ethernet interface.

Deployment overview:

Ad hoc-peer-to-peer communicationsystems have traditionally operated in unlicensed spectrum. This paper is different—we are proposing to deploy an ad hocnetwork to extend managed services by cellular provides Unlicensed spectrum. This has important benefits for usersaswell as network providers. Users get more predictable performance,because the interference is managed, and an extendedbattery life, because fine-grained synchronization enables lowduty-cycle operation. (FlashLinQ is designed to leverage anyof CDMA/GSM cellular timing [4], DVBH timing [5], GPStiming [6], along with in-band timing.) In addition, networkproviders get increased spectral and power efficiency. As anaside, we note that FlashLinQ can be deployed in a mixedlicensed-unlicensed spectrum configuration; indeed, licensedspectrum communication, since it is inherently more reliable, can be used as a control layer in which, for example, peersdiscover each other and negotiate the use of unlicensed spectrumfor bulk data traffic.

CONCEPTS IN THE FLASHLINQ:

1. Motivation for Flashlinq scheduling

2. Related works

3. PHY/MAC architecture

4. Implementation and simulation

These are all the steps we are going to see in this paper

1. MOTIVATION FOR FLASHLINQ SCHEDULING:

The goal of FlashLinQ scheduling is to find, forevery time-slot, a *maximal* feasible subset of links, i.e., a set oftransmissions that can simultaneously coexist with each other while maintaining a sufficiently large SIR, among all the (directed)links that have data to transmit. Note that the notion of"sufficiently large" depends on the desire rate. Under a simplisticbinary interference model in which either a given linkinterferes with another link, say , to such an extent that ifit transmits, then cannot maintain adequate SIR, or the linkdoes not interfere with at all, a maximal subset correspondsto an independent set in a directed graph whose vertices correspondto directed links and whose edges indicate interference.Roughly, the vertices are connected by (oriented)edges that indicate an exclusion condition, e.g.,indicates that link cannot transmit if link transmits.More generally andmore realistically, a link contributes someinterference to depending on transmit power and channel conditions.

To illustarte the inportance of the SIR in the link scheduling .consider a fixed transmitter –reciever pair(donated by Tx-A,RX-A)over which data transfer is to take place .the key probl;em in resource allocate is

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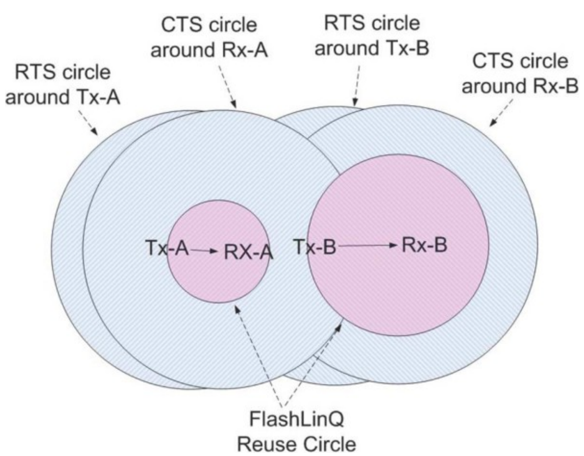
to determine which other link (transmiter and reciever)is to pair simultaneously transmit without an creating too much interface at RX-A.

so what we came to the concept CSMA/CA (carrer sense multiple access /collision avoidance) at before they werte used a collision detection instead of using detection we can use a avoidance to avoid an collision it's a advanced method to protect our data where equivalent to both we were used protection circle of a radius around them in any transmitter within these circle of radius is not permitted to transmit simultaneously.



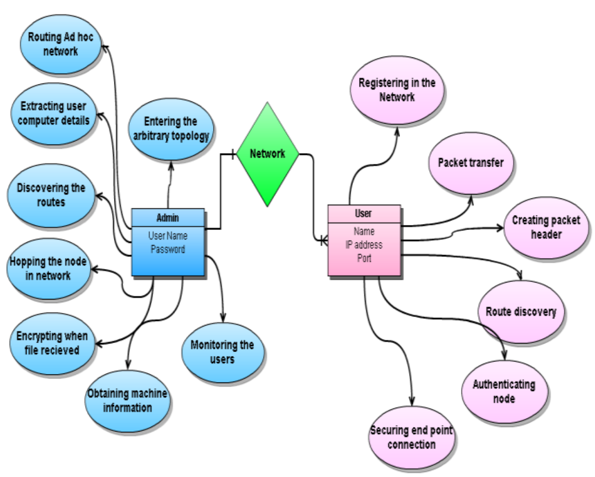


Fig 3.2 system architecture diagram

This mechanism ensure that always "TX-A " is closely related to "RX-A".In this where TX-A which is acts as a intended transmitter and RX-A which is acts as a intended reciever.a potential receiver Rx-B. From communications theory, we know, however, that this type of protection is, in general, neither necessary nor sufficient for optimal performance3: *Successful decoding occurs atRx-A as long as the SIR is sufficiently large to permit messagedecoding*. Ensuring successful decoding (at adequate rate)
is very different from requiring a maximum interference levelat Tx-A or Rx-A—what we really need to ensure is the *ratio*of signal power to interference to be large enough. This implies that the protection circle drawn by Rx-A should be of avariable radius that is proportional to the RF-distance between Tx-A and Rx-A. This is illustrated in Fig. 1. As we will showin Section III-A, this condition ensures a fixed SIR protection at Rx-A from Tx-B. With this mechanism, much more efficientchannel-aware spatial packing occurs. Consequently, our SIR-based mechanism leads to a channel-state-aware maximal
matching (see Section III-A) that can achieve spatial through put gains over an 802.11g system

2.RELATED WORKS:

Distributed scheduling in wireless networks has attracted the attention of many researchers over the last several years. Interesting results and insights have been obtained concerning the potential throughput loss suffered by a class of *maximalmatching* distributed scheduling algorithms, as compared to agenie-aided centralized algorithm. Various ways to improve the maximal matching have been proposed. In particular, recent results in this field show that queue length- based distributed scheduling can be *throughput-optimal*. Many of these schemes assume a combinatorial interference model at the physical layer and focus on scheduling links given the *feasible* independent sets, i.e., subsets of links are allowed to transmit simultaneously according to the combinatorial interference model. The possibilities raised by defining feasible independent sets using actual SIRs under fading channels (channel coefficients that can change on a per-time-slot basis) and then incorporating multiple power levels and transmission rates are usually not addressed.In parallel, there has been a growing interest in integrating advanced physical-layer techniques, including network coding,Interference alignment, and cancellation into existing wireless networks. The emphasis of these works is to show the practicality of these techniques in a real network rather thantheoretically characterizing the potential gain. Most of these analyses and prototyping efforts are based on the WiFi physicallayer, where OFDM is used only as a point-to-point physical-layer technology, i.e., both control signaling and data transmissionsuse full bandwidth to transmit rather than trying tomultiplex users in the frequency domain. In this paper, we study

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distributed maximal-matching-type scheduling protocols based on an SIR model on top of afully implemented OFDMA-based PHY layer. As compared to CSMA/CA with RTS/CTS-based protocols proposed for802.11 [20], the key differences here are threefold: 1) No CSMA is needed after introducing a new synchronous PHY; 2) the signaling equivalent to RTS and CTS are very different in FlashLinQ, exploiting the OFDMA-based PHY; 3) the yielding decisions are SIR-based rather than signal-to-noise ratio (SNR)-based as in 802.11.We show that a significant gain in spatial reuse can be achieved in FlashLinQ.

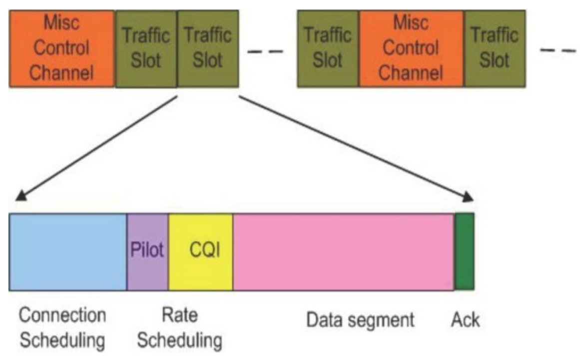
III. PHY/MAC ARCHITECTURE

The FlashLinQ peer-to-peer system has been designed to operate synchronously in 5 MHz of bandwidth, with protocols enabling distributed, channel-aware spatial scheduling. The underlying physical-layer technology used for FlashLinQ is OFDM/OFDMA. OFDM is a well-known frequency-division multiplexing (FDM) scheme. OFDMuses a digital multicarrier modulation method that effectively reduces the channel to a set of orthogonal elementary complex degrees of freedom organized into a set of distinct carriers (tones). OFDMA is a multiuser versionof OFDM that exploits the physical-layer orthogonality to easily orthogonalize usersOFDM/OFDMA has been the underlyingtechnology for many advanced wireless systems such as 802.11g LTE, and WiMAX. We refer for an excellenttutorial on OFDM and OFDMA. OFDMA requires *timing synchronization* among multiple devices, whose application is extended in FlashLinQ to provide a foundation for efficient operation of all of its key aspects. Synchronization underpins the entire system by providing the basisfor OFDM orthogonal signaling and the ability for all devices to operate simultaneously with low duty cycle.
There are two key aspects of FlashLinQ's distributed resource allocation protocol that are founded on the OFDMAsignal structure.

1) ***Signaling mechanism****:* We exploit the flexibility of parallel, single-tone channels afforded by OFDM to construct an energy-level-based (analog) signalling mechanism that provides a miniaturized template of data transmissions, but *without collisions*. This mechanism enables all links to observeand infer (both from interference and rate perspectives) what *would* happen if they were to transmit data, but without actually spending the resources needed to performthe data transmissions and without realizing the resulting contentions.

2) ***Spatial packing:***By carefully choosing the energy level at which single-tone signals are transmitted, this analog and parallel signaling mechanism enables each link (Tx–Rx pair) to determine the degradation to the SIR that it causes at each receiver. This enables a feasible set of transmissionsto be determined taking into consideration the link qualities that result from choosing this feasible set. As we discussed earlier, this is critical to ensureefficient spatial packing. The scheduling operation occurs every 2.08 ms in FlashLinQ.On a slightly longer timescale, there occur the following twoprocesses fundamental to the FlashLinQ system.

1)Peer discovery: This enables nodes to transmit presence information and detect the presence of other nodes in the neighborhood.
2) ***Link management****:* This allows nodes to operate in power saving mode and to page and be paged as needed for the purpose of establishing links (assign link IDs). In the remainder of the section, we present a detailed description of scheduling and resource allocation, followed by an abridged description of timing synchronization, peer discovery, and link management.



A. Scheduling and Data Transmission

This section contains the main technical contribution of thepaper a low-overhead distributed scheduling algorithm. We
first describe the key ideas underlying our algorithm and thendescribe the signaling mechanisms that enable the approach.
As discussed in Section I-A, the goal of FlashLinQ is toschedule a channel-state-aware *maximal* feasible set of linksfor any given time-slot based on the current traffic and channelconditions. The feasible set is defined based on the link SIRs,all links in the chosen independent set simultaneously havea "large enough" SIR.
1) Key Design Ideas*:* To present the key elements of the algorithm , We first consider a simple two-link example. We consider links and as shown in Fig. 3.Here, the two links4 have direct-link gains , and cross-link gains, . If the cross-link gains are small

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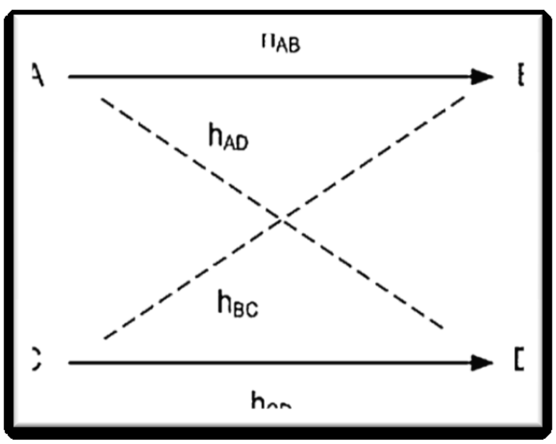
compared to the direct-link gains, then the links and will not significantly interfere with each other and can therefore be simultaneously scheduled. On the other hand, if the cross-link gains are relatively large, then only one of the links can be

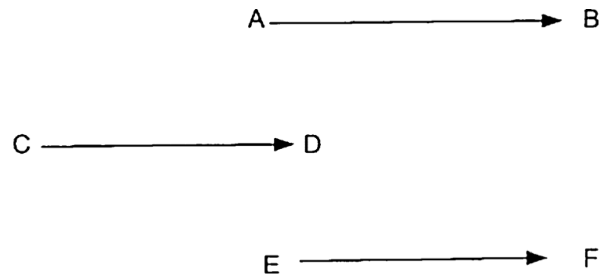
scheduled at any instant of time. If only one link can be scheduled, there arises the problem of selecting that link .simple way of resolving the ambiguity while also providing a basis for determining the interference scenario is to assign *priorities* to links. The assumption is that, in this setting, the higher-priority link will be scheduled. The low-priority link, however, will not be scheduled only if its transmission will cause excessive *SIR damage* to the high-priority link. This is determined by comparing the *would-be SIR* of the high-priority link to an *SIR threshold* assuming the low-priority link does in fact proceed with its data transmission.



To be more precise, in the two-link example in assume link has higher priority in the current slot. Link can potentially be scheduled simultaneously if *does not cause*

too much interference to . To define this, we require the SIR of link assuming is transmitting (and ignoring other potential interferers), to be at least dB.5 Thus, the protection condition can be written as where denotes transmit power used by node and denotes transmit power used by node . In our system, power control of the links is performed on a timescale slower than scheduling so transmit power does not change dynamically from slot to slot. We do not discuss the power control algorithm here. However, the scheduling algorithm presented here works for arbitrarypower levels .We remark that a final optimization of link usage prior to data transmission is effected through rate selection, which occurs after connection scheduling.

Flashlinq



These two mechanisms ensure, in the two-link scenario, thatthe high-priority link is protected and both links get scheduledonly if the cross-link gains are “weak enough.” By randomizingthe priority of links over time, a basic level of “fairness” acrosslinks can be maintained in the sense that all links will have accessto the spectrum with a scheduling probability of at leastor the inverse of the neighbour size of link . Here, two linksare said to be neighbours of each other if they cannot be scheduledsimultaneously under the constraints of (1) and (2).So far, we have illustrated the following three key elements ofour algorithm in the simple network 1) a fair priority assignment mechanism; 2) a transmityielding criterion to protect the receiver in higher-priority links;and 3) a receive yielding criterion to further improve networkspatial packing in a multilink scenario. The system design needsto provide the relevant devices a means to check these criteria.Device c needs to determine the left-hand side (LHS) of (1),which involves not only the cross-channel gain hBC , but also paand hAB . Similarly,D needs to determine the LHS of (2),which involves not only the channel gain , Hcd but also pA and Had Our main contribution is a signaling protocol by which CAnd D infer the relevant information based on minimal transmissionsFrom A and B . In particular, the protocol does not requireany dedicated signaling between links AB andCD . Themain mechanism used to enable distributed determination of theabove two criteria by providing the information needed to estimatevarious SIRs is a two-analog-tone-signal exchange consistingof a*inverse power echo* and a *direct power signal*. Thetwo signals will be described in the context

Algorithm Description:In the network setting, we consider a cascaded scheduling algorithm where the priorities of the links are arranged in a pseudo-random order, and links scheduled in a sequential manner.

In other words, the links are strictly orderedaccording to a random priority list. A link at priority level is scheduled if and only if *both* the transmitter and the receiver of link decide to allow data transfer over this

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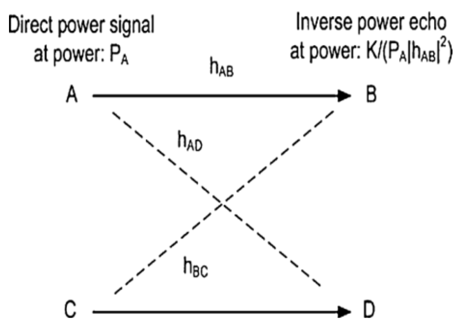
link. It will decide to transmit under the following conditions.

• ***The link L does not cause too much interference to an already***
Scheduled link: We define this to be satisfied if the SIR of an already scheduledlink due to interference from link to be at least dB. If this is not satisfied,*Tx-yielding* (transmitter yielding) occurs, where the transmitter node of link decides not totransmit in order to satisfy SIR constraints at higher-priority receivers.

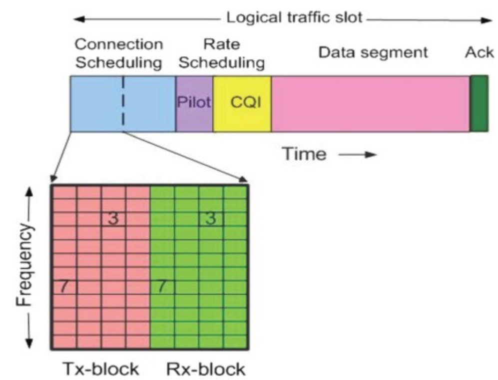
• ***The link L will see a reasonable SIR if scheduled:*** We definethis to mean that the SIR of link is at least dB, where the interference is taken to be the *sum* of interference from all higher-priority links. If this is not satisfied, *Rx-yielding* (receiver yielding) occurs, where the receiver node of link decides not to allow data transfer over this link. As we discussed earlier, this allows for more efficient spatial packing.



Direct power signal and echo signal

3) Signaling Design: As discussed earlier, the basic data transfer unit is a time-slot, with each slot being 2.08 ms in duration.Each slot occupies the entire 5 MHz, and a scheduling decision Is made on per-slot basis and independently of other slots.
Furthermore, each slot is divided into four physically separate sub channels connection scheduling, rate scheduling, data segment, and ACK, each described as follows.
Connection Scheduling: Each link has an associated locally unique connection ID (or CID) that is an index between 1 and 112, which is acquired as part of the link management process. When there are more than 112 links present in a collision domain, new devices cannot find a free CID in the "slower" link management, and thus cannot participate in the FlashLinQ scheduling phase (see Section III-D for more details on CID acquisition). They, however, periodically probe for a free CID;when available, they can capture it and then participate in connection scheduling and data transmission as described inthe following. For every slot, connection scheduling signaling consists oftwo signaling blocks: Tx-block and Rx-block, as shown in Both Tx-block and Rx-block have four OFDM symbols with fast Fourier transform (FFT) size 32, i.e., each symbol has 32 different tones (or subcarriers), out of which 28 are usable for signal transmission. A link with an assigned CID corresponds to a pair of single tones, one in Tx-block, to be used for transmitter, and the other in Rx-block, to be used for receiver. The mapping from the CIDs to the actual tone pair within the connection scheduling blocks is randomized (every time-slot, a new mapping is used).

STRUCTURE OF CONNECTION SCHEDULE:



Rate Scheduling: All transmitters that were scheduled to transmit in the connection scheduling slot will use the ratescheduling channel to determine the code rate and modulation that they should use for the data segment. This channel is composed of a wideband PILOT sent by transmitters *simultaneously* and a channel quality indicator (CQI) sent by the receivers. This slot-by-slot rate estimation achieves a moreaccurate estimation of the SIR (based on total interference)than in connection scheduling because each link's code rate andmodulation is chosen based on the actual SIR corresponding tothe final outcome of the scheduling mechanism.

Data Segment:All scheduled links transmit over all tones.Note that single-tone signals are used only during connectionscheduling, and our mechanism ensures that simultaneous transmissionsover the various links do not significantly interferewith each other.
Acknowledgement: Acknowledgement uses orthogonalchannels based on the CID to signal successful reception of thepacket. There is a dedicated slot used for acknowledgment sothat theacknowledgement signals do not interfere with othersignals.
4) Advanced Features of the Design: In the previous sections,we described the baseline design ofFlashLinQ connectionscheduling where multiple links can share the bandwidth ina *fair* way. This baseline design can be easily enhanced to supportmanyadvanced features,

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including support forQoS,MIMOscheduling, frequency-band splitting, and multicast/broadcastmessages. Here, we describe the main ideas to support thesefeatures in FlashLinQ, showing that they do not require significantadditional overhead.

Quality-of-Service (QoS) Design: The baseline FlashLinQconnection scheduling protocol enforces a random priority allocationamong links. Over time, this mechanism makes sure alllinks obtain a similar share of the channel use. However, it is desirablefor the system to be able to give higher priority to certainlinks over others and support hierarchical QoS levels. Toward this end, the tone matrices that we have described are splitinto multiple subblocks representing different priority levels(priority ordering across blocks of tones). A link is assignedmultiple tone-pairs—at any time-slot, the choice of which tonepair to use dynamically depends on the queue-length/backlogor packet delay.We have used this mechanism to study a simpleversion of the back-pressure algorithm for tone-pair selection,and have observed the anticipated QoS performance gains.

Multiple-Input–Multiple-Output (MIMO) Design: Proper useof multiple antennas can bring tremendous gains to ad hoc networksand, moreover, these gains are *much easier* to obtain insuch networks as compared to the traditional cellular communications.

First, all antennas are at low ground level, and the*angular spread* between two users is typically larger than thecellular case, where the base-station antenna is usually placed30m above the ground. Large angular spread is critical to enablespatial multiplexing between a Tx–Rx pair.

Second,the channel matrix information is easier to obtain due to thetime division duplexing (TDD) nature of the channel in ad hocnetworks. Third, the restricted association nature between thetransmitter and receiver creates a rich interference environment.Even simple beamforming schemes can reduce the *protectionCircle***1) *Synchronization***: FlashLinQ is a time-slotted system. Thisallows FlashLinQ to have dedicated slots for connectionscheduling as well as rate scheduling. The direct impactof this is that it reduces system overhead. A more indirectbenefit for FlashLinQ is that it enables many algorithmsmthat are hard to implement in an asynchronous system. Arguably,one can incorporate many of the ideas in this paperinto 802.11, but the asynchronous nature of 802.11 makesthe implementation significantly more difficult, and the resultinggains much lower.

2) ***Tx-Rx yielding:***In FlashLinQ, transmitters yield onlybased on receiver echoes and do not yield to othertransmitters. Similarly, receivers yield only to other transmitters.This is in contrast with 802.11, where transmittersand receivers both yield to transmitters (CSMA/CA) ortransmitters and receivers both yield to transmitters aswell as receivers (RTS/CTS). The FlashLinQ approachenables more spatial reuse and solves the hidden nodeproblem without a spatial reuse penalty.

3) *Spatial reuse:*In 802.11, the reuse decisions are madebased on sensing, meaning that the reuse radius is fixedand independent of the length of the primary link. Furthermore,the reuse region is drawn around the transmitterand excludes both transmitters and receivers. This makesthe 802.11 reuse decision highly suboptimal, particularlyfor short links. On the other hand, in FlashLinQ, the reuseradius depends on the primary link length; the shorter theprimary link, the shorter the reuse radius.

4) *Power control*: In FlashLinQ, short links can use lowertransmit power and hence can coexist with long links thatuse higher transmit power. This is akin to being able towhisper (short-range communication) in a large lecture hallwithout interrupting the lecture for other audience members(long-range communication). IT can transmitto at lower power since is close to, thereby allowingto transmit to simultaneously. We discussedthe power control issue in much greater details in a separatepaper

5) *Rate scheduling*: In FlashLinQ, we have dedicated per-slotrate scheduling in which interference estimation is donebefore every transmission. This provides much more robustrate scheduling than 802.11 rate scheduling, which istypically based on ack/nak. It is particularly useful in a dynamicinterference environment.

6) *Range*: From a link budget point of view, FlashLinQ'straffic link is supported at 14 dB lower power than 802.11,thus inherently supporting longer links.

IV.IMPLEMENTATION AND SIMULATIONS:

In this section, we evaluate the efficiency of FlashLinQ linkscheduling by experiments using the FlashLinQ prototype devicesand also simulations.

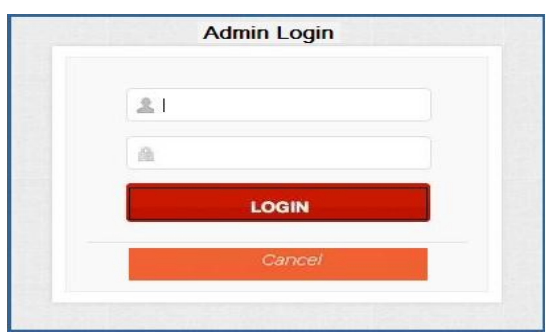

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Fig. Admin login

Fig: Client login

Fig: Client Registration

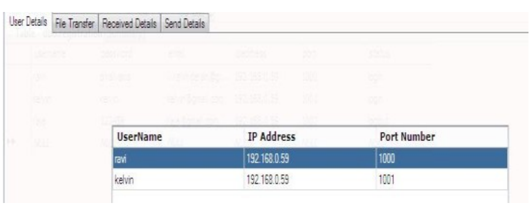

Fig: Online clients

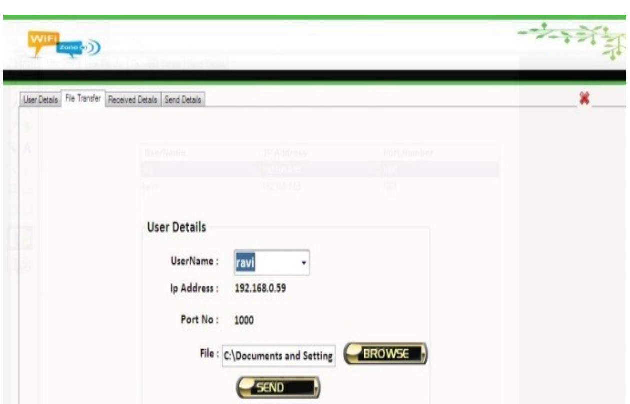

Fig: Client file transfer

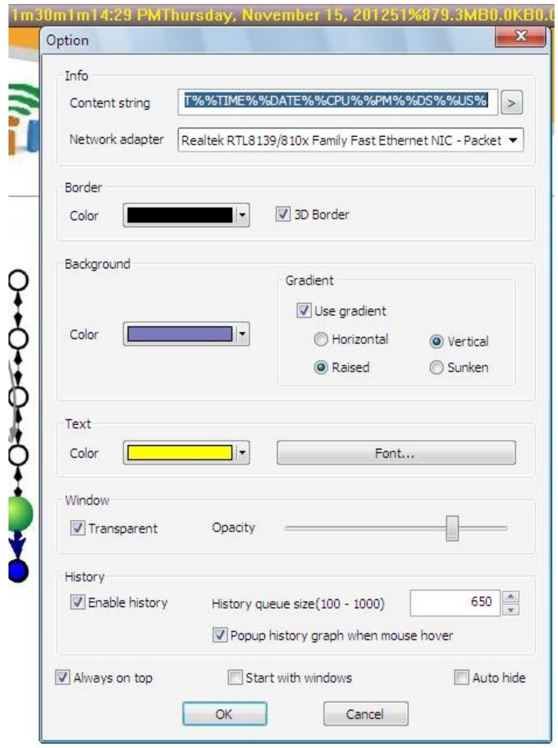

Fig. User monitoring

Fig: Client details

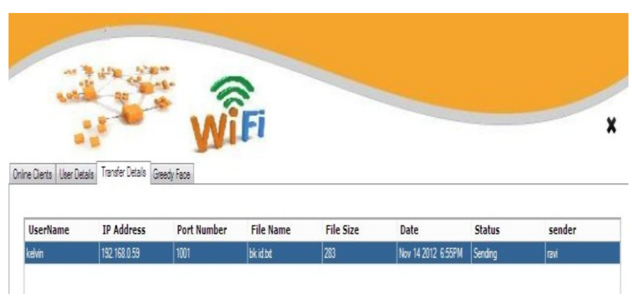

Fig: Transfer details

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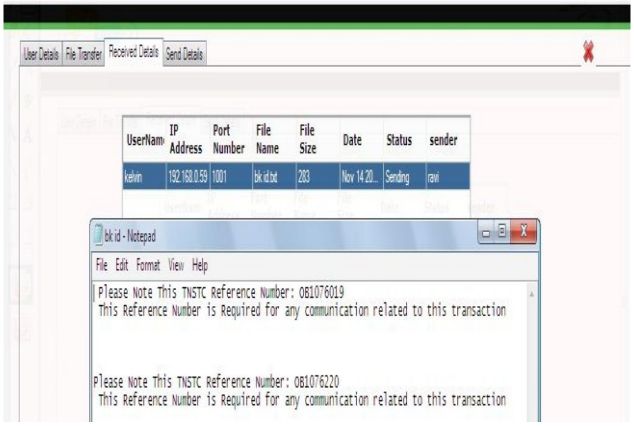

Fig: Opened files

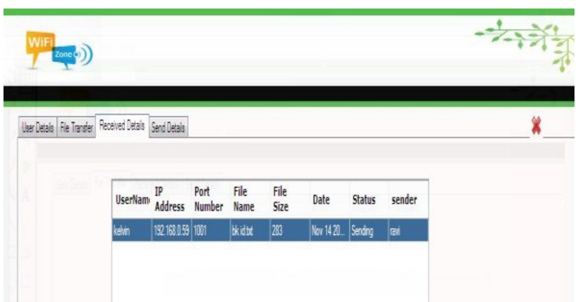

Fig: Received details

A. Measurement Setup and Results

The FlashLinQ prototype modem is based on a general FPGA/DSP-based platform that operatesat 2.586 GHz carrier frequency. We chose TI DSPchipset TMS-C6482 and XiLinx Virtex-4 FPGA to build theOFDMA-based FlashLinQ physical-layer modules. Specifically,the time-domain sample rate processing and FFT areperformed in the FPGA, and frequency-domain symbol-levelprocessing is performed mainly in the DSP. As a result of thisseparation, the link scheduling algorithms reside in the DSP.Further implementation details are available

Our experiments are conducted with four devices namedAMC Theaters (AT), Movie Buff (MB), Teen Shopper (TS),and Pub Patron (PP). The first set of results shows howFlashLinQ devices make transmitting or yielding decisions(spatial packing) at different channel conditions. In this experiment,we have four devices forming two links, one between ATand MB and the other between TS and PP. We let the four ofthem sit on a straight within a room.In the beginning of the experiment, we let the two transmitters,TS and AT, stay at the far sides of the picture (about 3 m awayfrom each other), and the two receivers, PP and MB, closeto their interferers. We then move PP and MB closer to theirtransmitters and thus create strong signal and weaker interferencefor both links.

B. Simulation Results

In this section, we present simulation results comparingFlashLinQ with a 802.11g protocol. Our simulations are basedon a detailed software implementation of both FlashLinQ and802.11g, and all signaling overheads are fully accounted. TheFlashLinQ system operates over a 5-MHz spectrum (for whichthis system is designed), whereas the 802.11g protocol operatesover a 20-MHz spectrum. Our results are hence normalizedto bits/s/Hz to account for the excess bandwidth for 802.11g.

For the WiFi protocol, as per 802.11g specifications, an energysensing threshold of 76 dBm and PLCP header decoding (at0.5 dB SINR) is used for yielding.

Before discussing the simulation settings, it is important tonote that there are several design modifications that can bemade to 802.11g, such as out-of-band SIR-based signaling, power and rate control, etc., that can lead to improved performanceof the 802.11g system. However, as our simulationsare based on a detailed software implementation, this wouldrequire us to fully spec-out such a system, which is beyond thescope of our work here. In any case, our main objective here isto demonstrate that we can indeed design a synchronous anddistributed opportunistic scheduling system that competes wellwith traditional 802.11g systems, even after accounting for allsignaling overheads.

CONCLUSION:

This paper proposes FlashLinQ—a synchronous peer-to-peerwireless PHY/MAC network architecture for distributedchannel allocation. The key scheduling objective has been todevelop a distributed, channel-aware maximal independent setscheduling algorithm. Our performance study has indicatedthat significant spectral efficiency gains can be obtained over802.11—and this is key for the licensed spectrum deploymentscenario.

Finally, we comment that FlashLinQis by no means optimal,and that there are several other design optimizations that canbe made in 802.11 systems to improve performance, as thevast literature in this research area indicates. However, Flash-LinQ demonstrates that we can indeed architect, design, andimplement a fast (time-slot-by-time-slot) *channel-aware opportunistic*synchronous system, that accounts for all signalling overheads and results in gains over a conventional 802.11system. This is of interest, given the considerable interest inslotted-time opportunistic scheduling that is an active area ofresearch today, and

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indicates that such systems may be a viablealternative to 802.11-based systems.

FUTURE ENHANCEMENT:

The enhancement which can be done is to extend the experimental methodology when the first setting is applied for the second task, to use additional sources of information as representation techniques, and to focus more on ways to integrate the research discoveries in a framework to be deployed to consumers. Vulnerability management organizations scan networks for IT vulnerabilities. They provide CVSS base scores for every vulnerability on each host. User organizations use this critical data stream to more effectively manage their IT infrastructures by reducing outages and protecting against malicious and accidental IT threats.

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