

ISHARE: EXPLOITING OPPORTUNISTIC ADHOC CONNECTIONS FOR IMPROVING DATA DOWNLOAD OF CELLULAR USERS

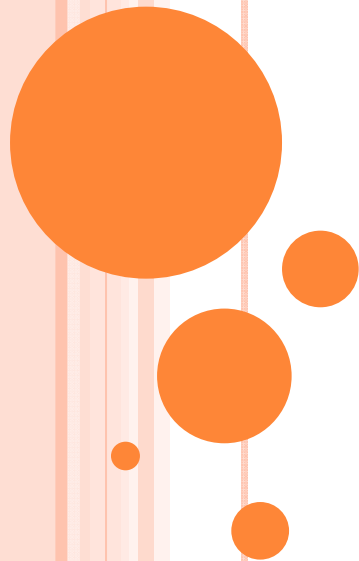
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OUTLINE

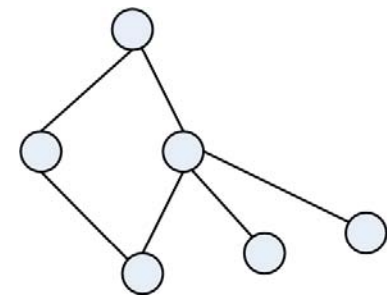
- Motivation
- System Model
- iShare Bootstrapping
- P2P Exchange
- Cellular Download
- Fair Sharing with Tit-for-tat
- Evaluation

P2P SHARING IS PRACTICAL IN MOBILE P2P NETWORKS?

- P2P applications are successful in the Internet
 - Nodes share mutual content interest (immediate incentive)
→ willing to share network resources
 - Co-location of nodes is important, but not crucial

- Mobile P2P networks

- Wireless communication is limited
 - Besides mutual content interest, **co-location of nodes becomes crucial**
- We present scenarios where P2P sharing in mobile P2P networks become practical



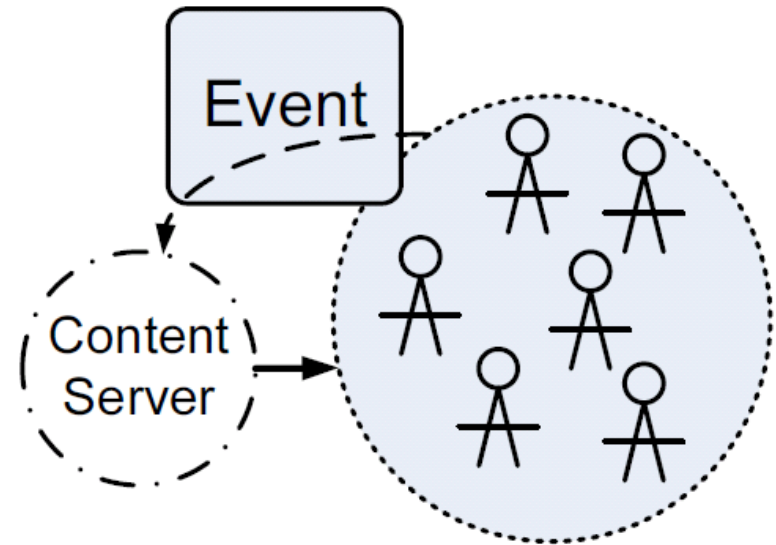
MOTIVATING SCENARIO (1): CO-LOCATED PEOPLE REQUEST CONTENT OF JOINTLY CO-LOCATED EVENTS FROM CONTENT SERVER

○ Example:

- Audiences of a costume festival at festival area
- Fans of a football match at stadium

○ Mutual Content:

- On-going events of costume festival
- Replay scene of football match



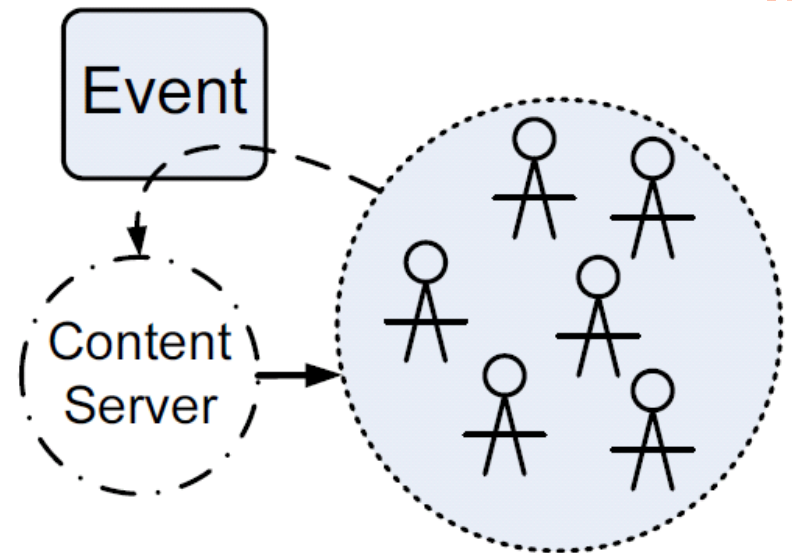
MOTIVATING SCENARIO (2): CO-LOCATED PEOPLE REQUEST CONTENT OF GLOBAL EVENT FROM CONTENT SERVER

○ Example:

- People are waiting for buses at bus station
- People are waiting for trains at train station

○ Mutual Content:

- Video of the last night social event from CNN website
- Video of American Idol Rewind from Youtube



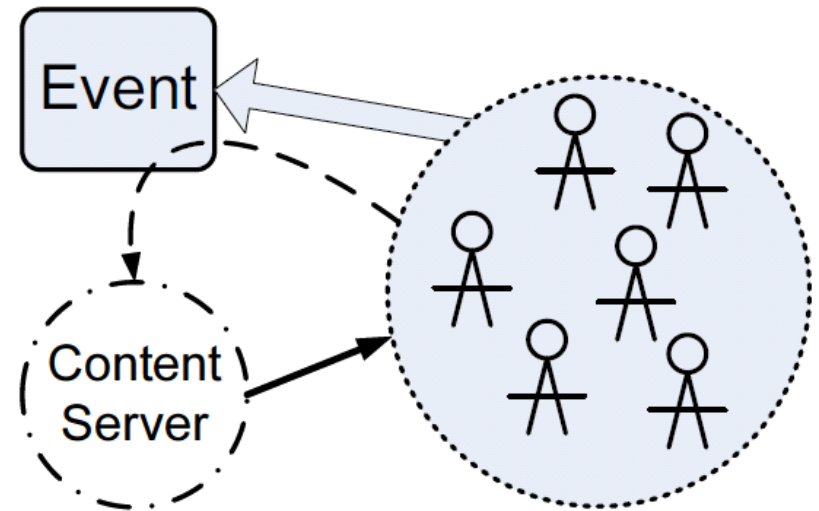
MOTIVATING SCENARIO (3): CO-LOCATED PEOPLE MOVE TOWARDS PLACE OF EVENT AND REQUEST EVENT CONTENT FROM CONTENT SERVER

○ Example:

- Customers are moving to shops
- Fans are moving to football stadium
- Drivers are heading to outdoor concert area

○ Mutual Content:

- Product overview video
- Player profile video
- Concert preview video

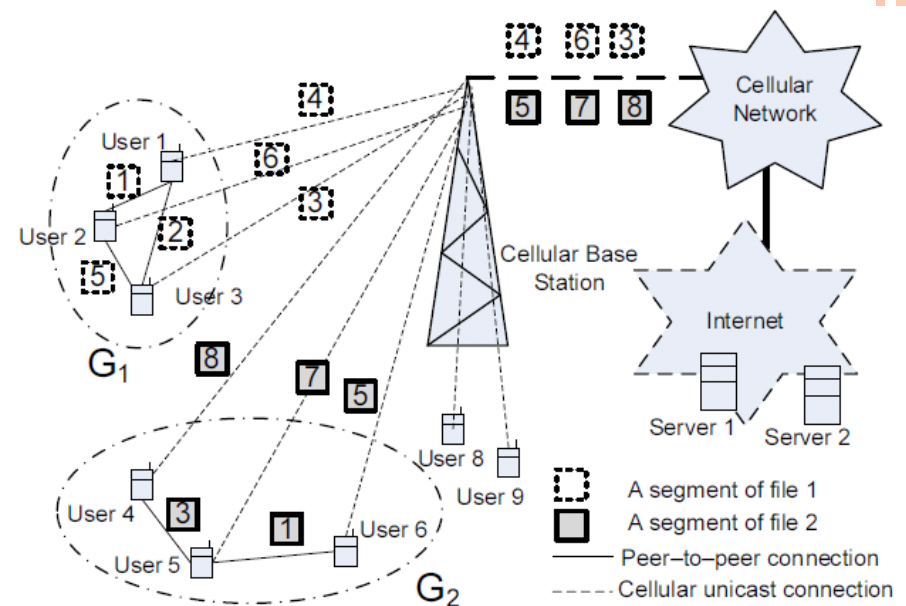


FANS MOVE TO FOOTBALL STADIUM

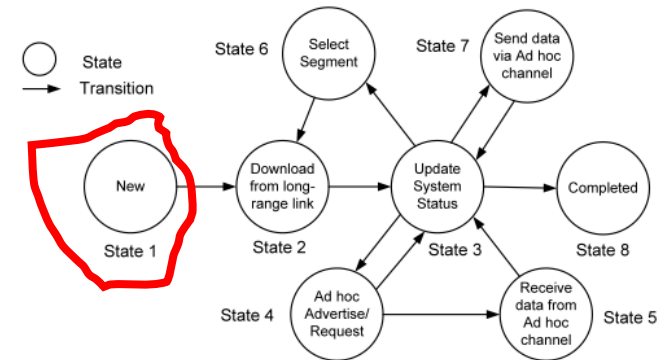


ISHARE SYSTEM MODEL

- Data Model
 - Video file
 - File has multiple segments
- Network Model
 - Co-located nodes form groups
 - Node has two interfaces:
 - Cellular
 - Peer-to-Peer (Wifi, Bluetooth, etc.)
 - Nodes form a mesh network



BOOTSTRAPPING ISHARE

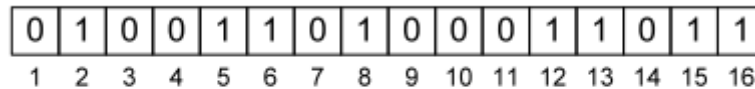


- At New state
- Node requests meta data of desired file from content server via cellular link
- Node downloads a random segment from cellular link

EXCHANGING DOWNLOADED SEGMENTS VIA P2P LINK

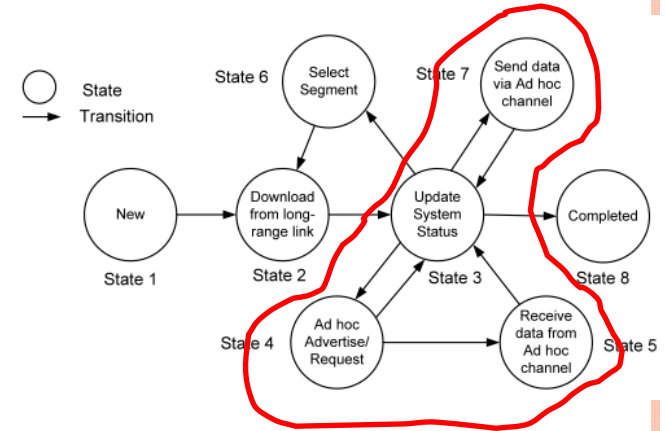
○ iShare periodically broadcasts local HELLO bit-vector message for:

- Advertisement
- Query

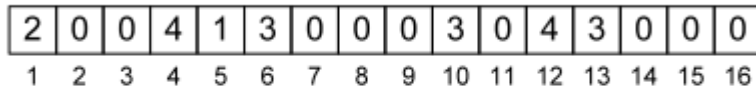


The HELLO message format

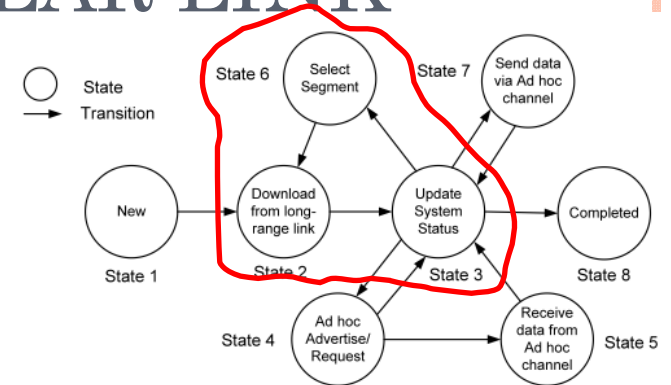
- HELLO message saves network bandwidth
- Node uses neighbor's HELLO bit-vector message to response to query



DOWNLOADING MISSING SEGMENTS FROM CELLULAR LINK



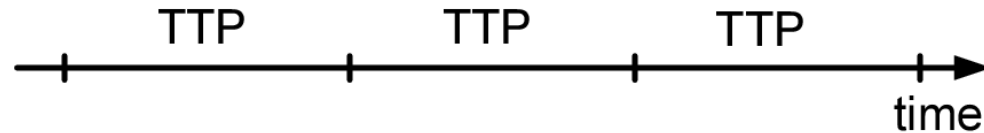
The aggregated HELLO message format



- Find missing segments in neighbors from **aggregated HELLO message**
- Download **least available segments**
 - In the local memory
 - In neighbors' memories
 - Break tie at random

FAIR SHARING WITH TIT-FOR-TAT

- Tit-for-tat period (TTP): Divide time into equal-sized TTP



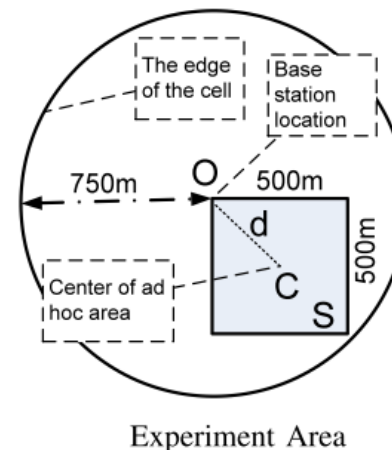
- For each TTP, a pair of nodes N1 and N2
 - N1 counts number of segments received from N2 in the last TTP
 - N1 sends to N2 the same number of segments needed by N2 during current TTP
 - **Segments are exchanged via P2P unicast link**
 - This provides fairness in P2P sharing and limits selfishness (as presented in Evaluation section)

ENABLING TIT-FOR-TAT IN MOBILE ENVIRONMENT

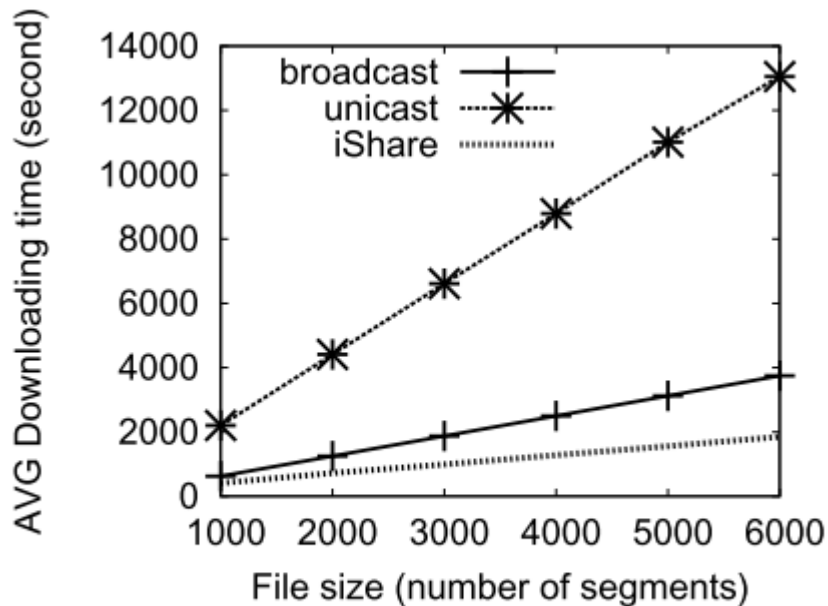
- Due to highly dynamic environment, we need to have new mechanism to enable tit-for-tat
 - Turn on promiscuous mode of Wifi channel to overhear messages destined at neighbors
 - Within each TTP, nodes broadcast several segments for free
 - This improves “Tit” step for the later “Tat” step
 - New neighbors can start Tit-for-tat immediately without wasting time on bootstrapping Tit-for-tat

EVALUATION

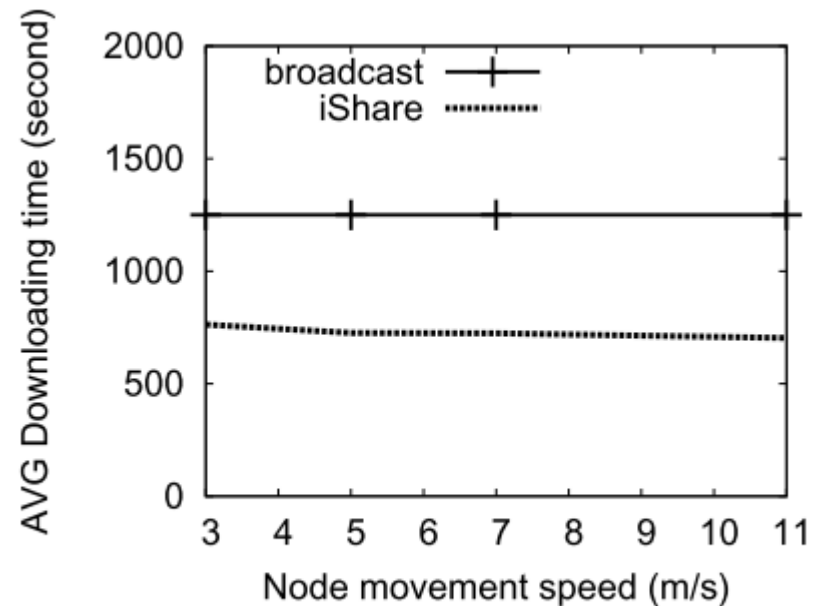
- Simulation is in NS2:
 - 30 background nodes don't use iShare to download content and content with iShare nodes
 - Proportional Fair Scheduler implemented at base station (with 1xEV-DO and rate 2.4 Mbps)
 - Decreased rate at further distance from base station
 - Node's transmission range is 125 (m)
- We compare iShare with:
 - Broadcast (fixed rate is 284 Kbps)
 - Unicast (rate depends on distance to base station)
 - Tree-based protocol



ISHARE SHOWS IMPROVEMENT IN DOWNLOADING TIME & NETWORK DYNAMICS



Impact of File size

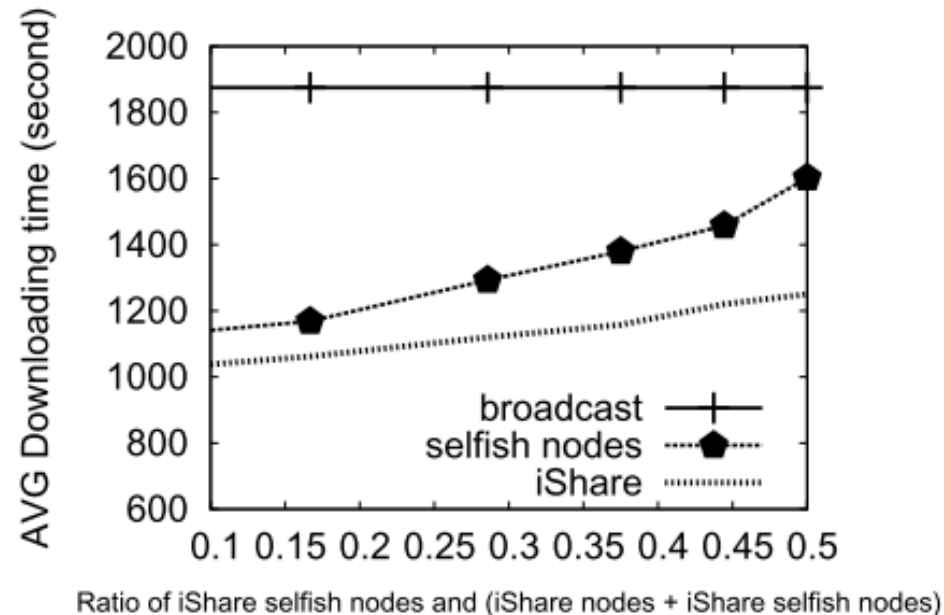


Network Dynamics

- For bigger file, iShare shows more improvement compared to Unicast and Broadcast
- iShare is robust to network dynamics

ISHARE COUNTERS SELFISH NODES

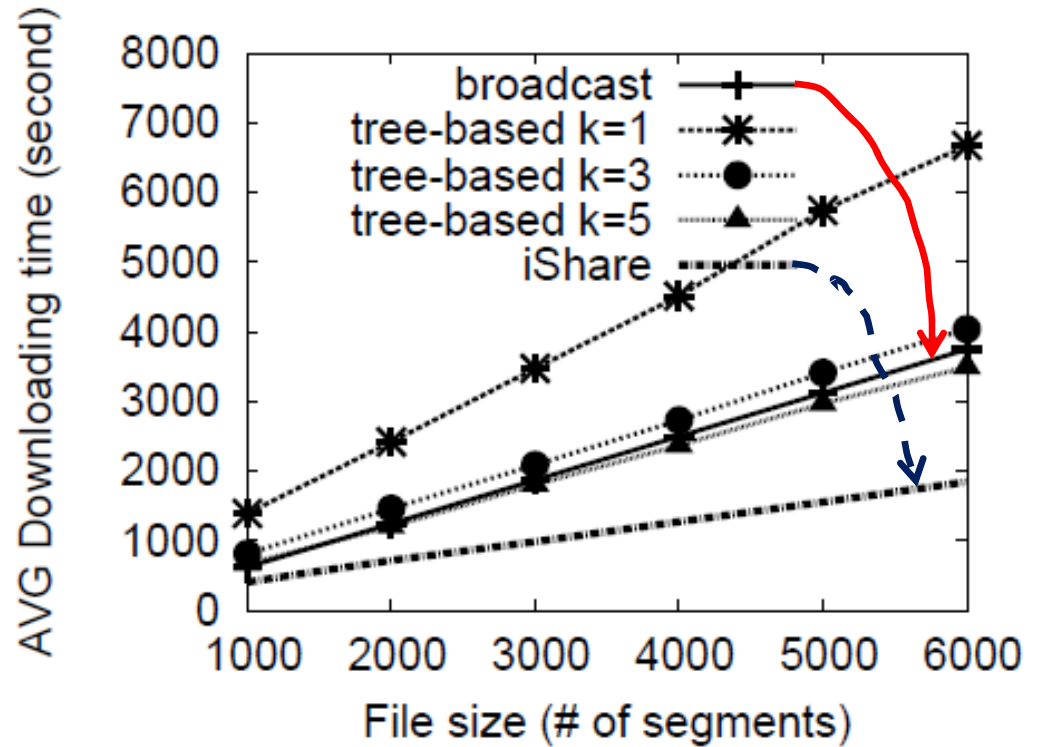
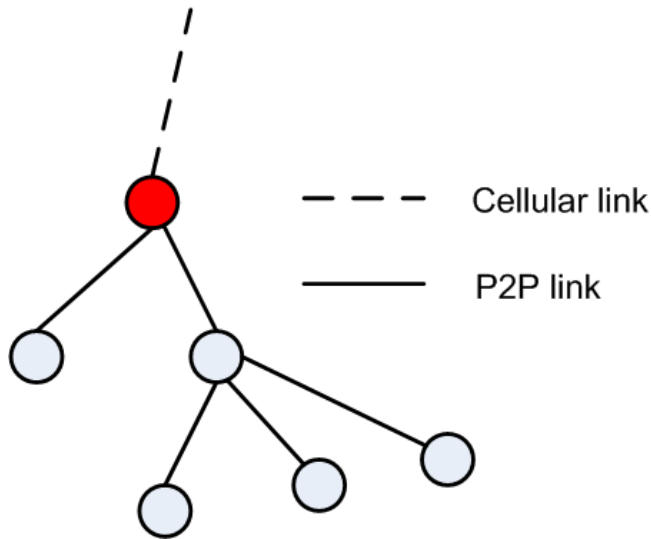
- Setting:
 - 15 iShare nodes and 1 to 15 selfish nodes
 - Selfish nodes use unicast cellular link to download and overhears iShare “tit” messages



Performance of iShare selfish nodes

- When more selfish nodes exist, they limit their performance themselves
- iShare nodes slightly suffer due to higher contention on cellular link

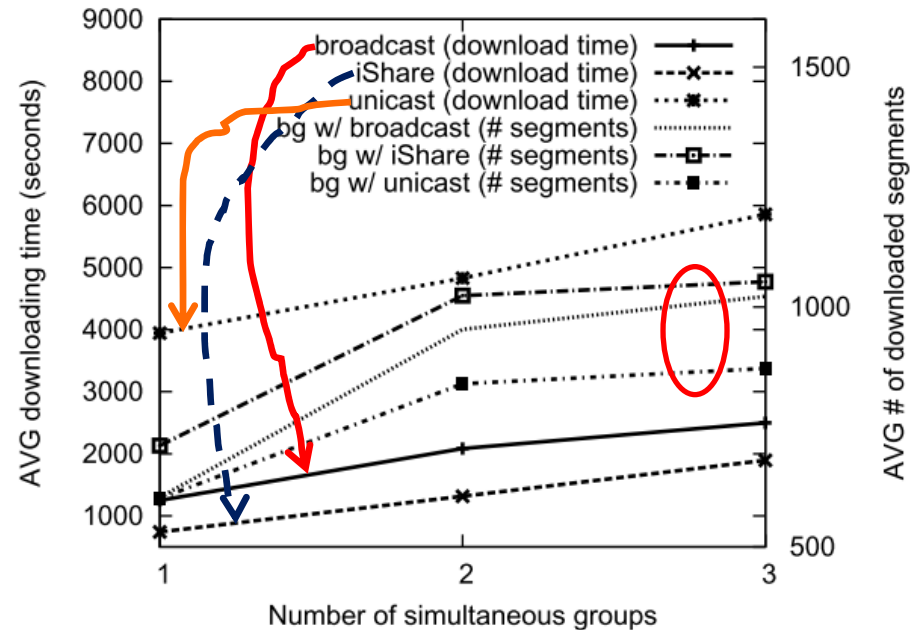
ISHARE VS. TREE-BASED PROTOCOL



- iShare creates a mesh network
- Tree-based protocol shows improvement when k increases
- iShare outperforms tree-based protocols

MULTIPLE GROUPS IN ONE CELL

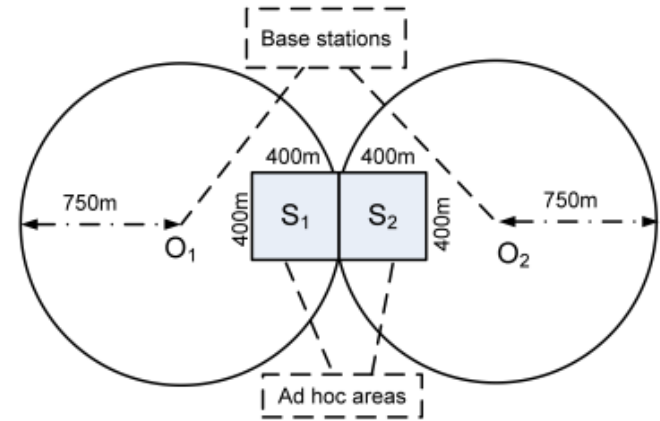
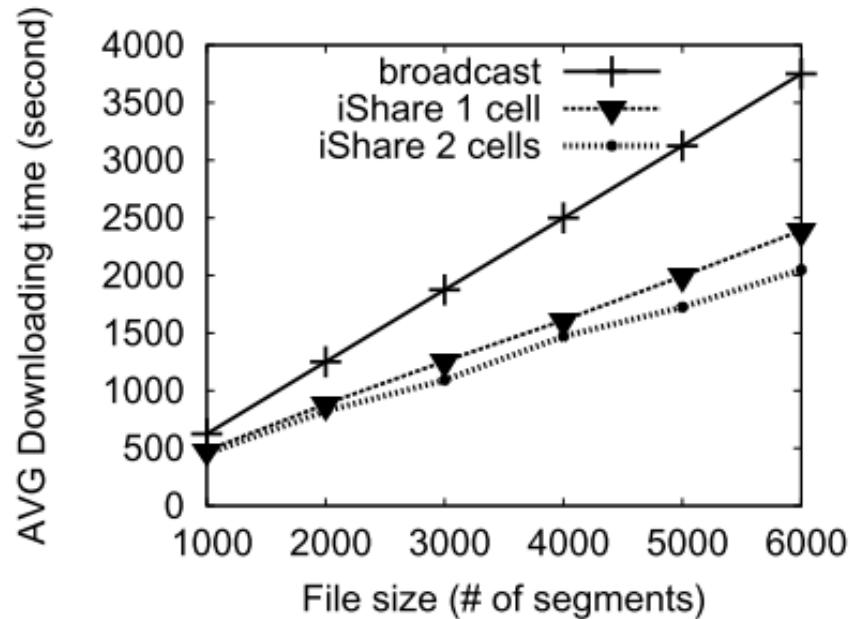
- Setting:
 - 3 groups, each has 10 nodes, in the same cell
 - No inter-group P2P communication



Performance of multiple groups in one cell

- For more number of groups, iShare's performance decreases due to higher contention on cellular link
- iShare outperforms Unicast and Broadcast
- When iShare is used, background nodes download more data

ONE GROUP SPANNING TWO CELLS



One group spanning two adjacent cells

- Setting:
 - G1 has 10 nodes, G2 has 20 nodes
 - 30 background nodes in each cell
- iShare improves performance of low-data-rate nodes at edge of cell

CONCLUSION

- **Contributions**
 - Provide light-weight and fair P2P sharing solution for mobile P2P networks
 - Present Modified version of Tit-for-tat for mobile P2P networks
 - Evaluate iShare thoroughly
- iShare is applicable for different combinations: cellular + Wifi, cellular + Bluetooth, cellular + Zigbee, etc.
- **On-going/future work**
 - Implement iShare on Google Android phones
 - Study tradeoff between download improvement vs. power consumption when using P2P communication

- Backup slides

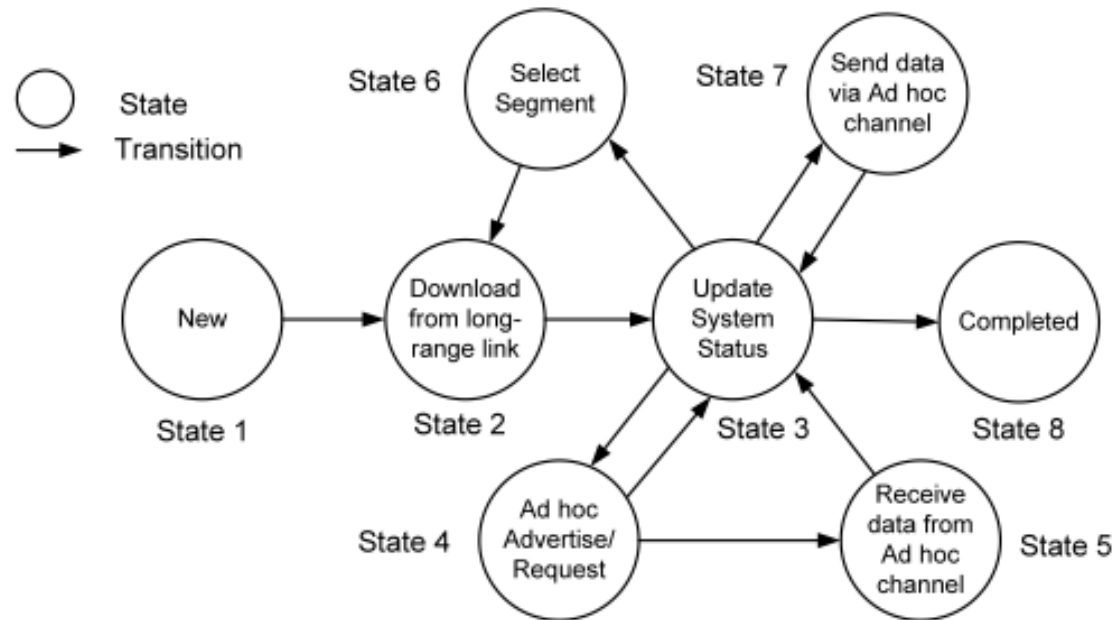
EXPERIMENT SETTINGS

Field	Value/Unit
Segment size	4KB
File size	[1000...6000] segments
Node ad hoc transmission range	125(m)
Base station radius	750(m)
Mobility model	Random Way Point
Node speed (Mobility-NS2)	[1,3,5,7,11] (m/s)
Pause time (Mobility-NS2)	5 (seconds)

RELATED WORKS

- Tree-based P2P sharing
 - Need changes in cellular infrastructure (costly), e.g., Mobicom 07, Pervasive 04, IEEE Transaction 06, Pervasive 07, Mobicom 04
- Mesh-based Video Sharing
 - Neither fair scheduler at base station nor background nodes, e.g., Percom extended abstract 09, ICCCN 2010
- Incentive mechanism
 - Complex (Mobiquitous 05, Mobihoc 03, NSDI 05)

ISHARE PROTOCOL STATES

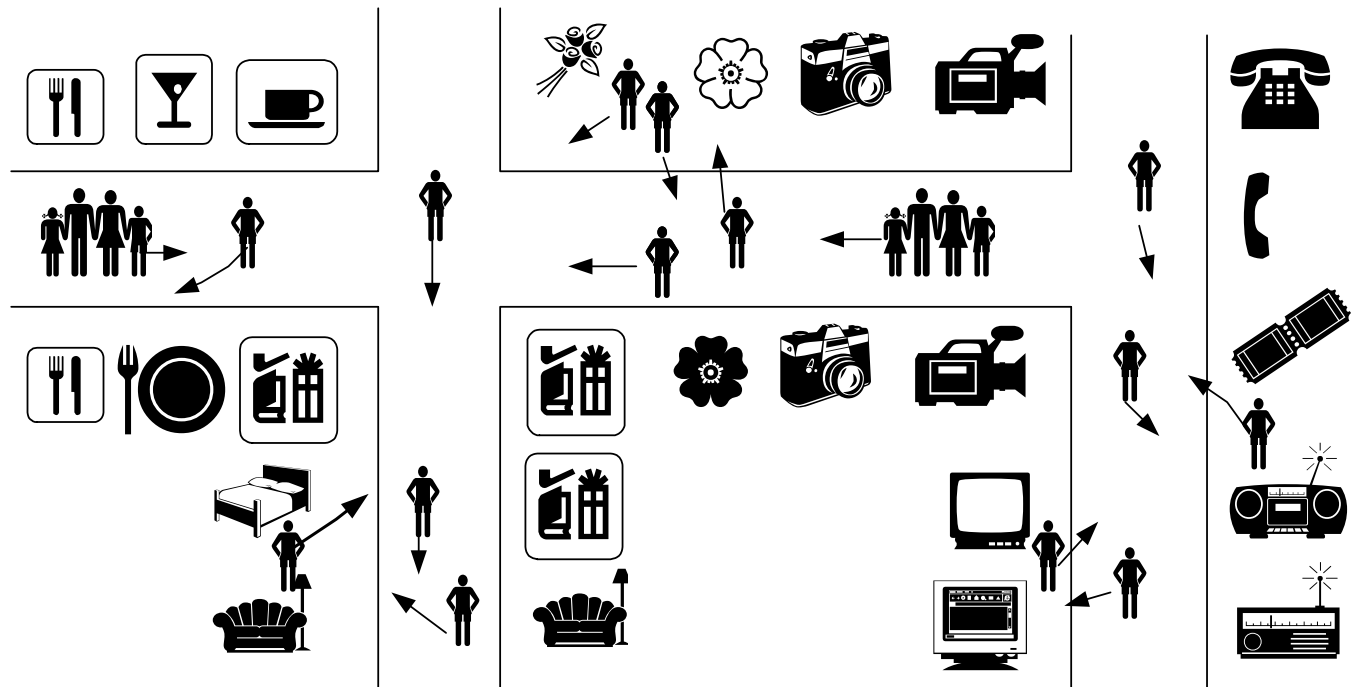


- Node downloads missing data segments from cellular link and at the same time exchange downloaded segments via P2P link
- Update local memory when a new segment downloaded via either cellular or P2P link

COMPLETE STATE

- Nodes have options to:
 - Immediately close P2P communications and do not share their downloaded segments
 - Close P2P communications after a specific period
 - Continue supporting other nodes via P2P communications

SHOPPING MALLS/STREETS



- Each shop is a **Point of Interest** providing videos of product advertisements, product information
- Customers moving towards the **same shops** have similar moving patterns (destination, speed)
- Customers can download the same video content



DISASTER AND RECOVERY

Each sub area is a
Point of Interest



People moving between sub areas in a disaster
area can download information about victims
and important area status



SOCIAL EVENTS IN URBAN AREA

