Games & P2P->Social->P2P :-

Some historical observations

Jon Crowcroft,

http://www.cl.cam.ac.uk/~jac22

Feb 23 2012

Outline

- Brief History of VR, P2P, OSNs
- Two Main Tech. Items
  - Real Life and Virtual Space/Affinity
  - P2P Capacity Lessons for Games etc
- AOB

What I do…

1. I don’t play games
2. I don’t download of P2P systems
3. I don’t like Online Social Networks
4. I’ve done extensive research on both
5. Since 1981…I’ve mostly mucked about with IP

Before the Internet

- Lots of proprietary, closed nets
- And Usenet (UUCP ++)
- *Muds, and Moos and Usenet*
- *HLA – first go at multicast/p2p games*
- *Napster and Freenet*
- *MMORPG – mostly Big Iron Server*
- *Facebook, Peerson, Diaspora – P2P OSNs*
- *Angry Birds and Ed Milliband*
- *Trust, Clouds and Fiber to the Home*

Avatar Movement in World of Warcraft Battlegrounds

1. John L. Miller and Jon Crowcroft

from at NetGames 2009

Motivation

- Lots of Online Game / DVE research proposing new message propagation models
- Typically evaluated against synthetic workloads
  - How do these compare to real workloads?
- Most DVE users play World of Warcraft (WoW)
  - Battlegrounds are a tractable, dynamic scenario

WoW battlegrounds

- Based in a fantasy environment: knights and wizards…
- Avatars organized into two teams: 'factions'
- Compete over resources or objectives
  - Dominate combat and geography
  - Mixtures of melee and spell/missile combat
- Battle duration: ~5 to ~30 minutes
- Battle participants: 10 - 240
- Both sides rewarded, winner > loser

Arathi Basin Battleground

500 yards

Scenario

- 10-30 players
- Control stationary flags
- First team to 1600 wins

Movement

- 7 yards/s Running
- 14 yards/s Riding

Interaction

- ~5 yard Melee range
- 30 (45) yard Spell range
- ~500 yard visual range

A Battle Excerpt

- Battle Excerpt Video
- Abstracted Moves (8x speed)

Data Acquisition

- Capture data using Windows Network Monitor 3.3
- Custom move extraction library
  - Parse .cap files into TCP payloads
  - Process payloads and extract movement data
  - Output .csv movement trace
- Gather landmark data
  - Join battle, circle around landmarks ☺

Data Gathering Methodology

- Join battleground with two grouped Avatars
  - Ensures they join the same battleground
- Move to opposite ends of the map, stealth
- Try not to fight or die
  - Team-mates don't like this
- Save resulting capture, filter observers

Capture statistics

- Analyzed 13 Battles
  - Scores from 1600-0 to 1600-1590
  - Observer team won 6, lost 7
- 392 unique avatars, 456 avatar instances
- Average avatar play interval: 69% of battle
- Average data continuity: 73% of interval

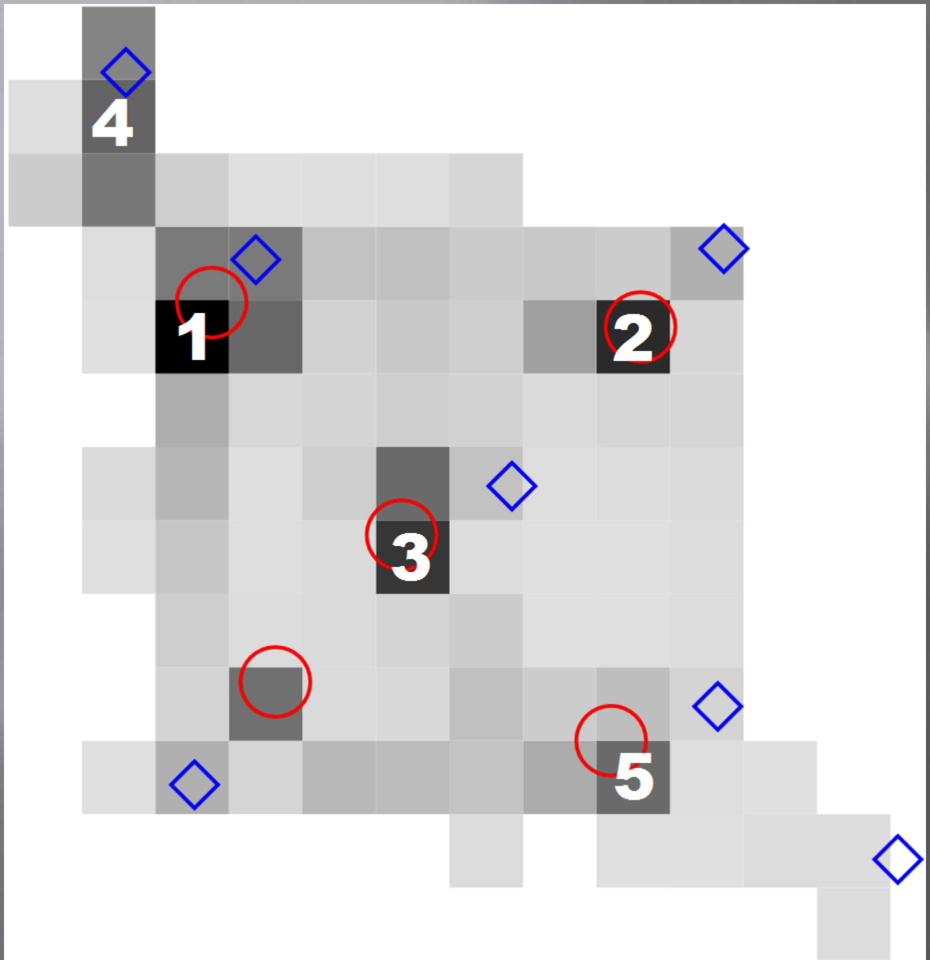
Analysis

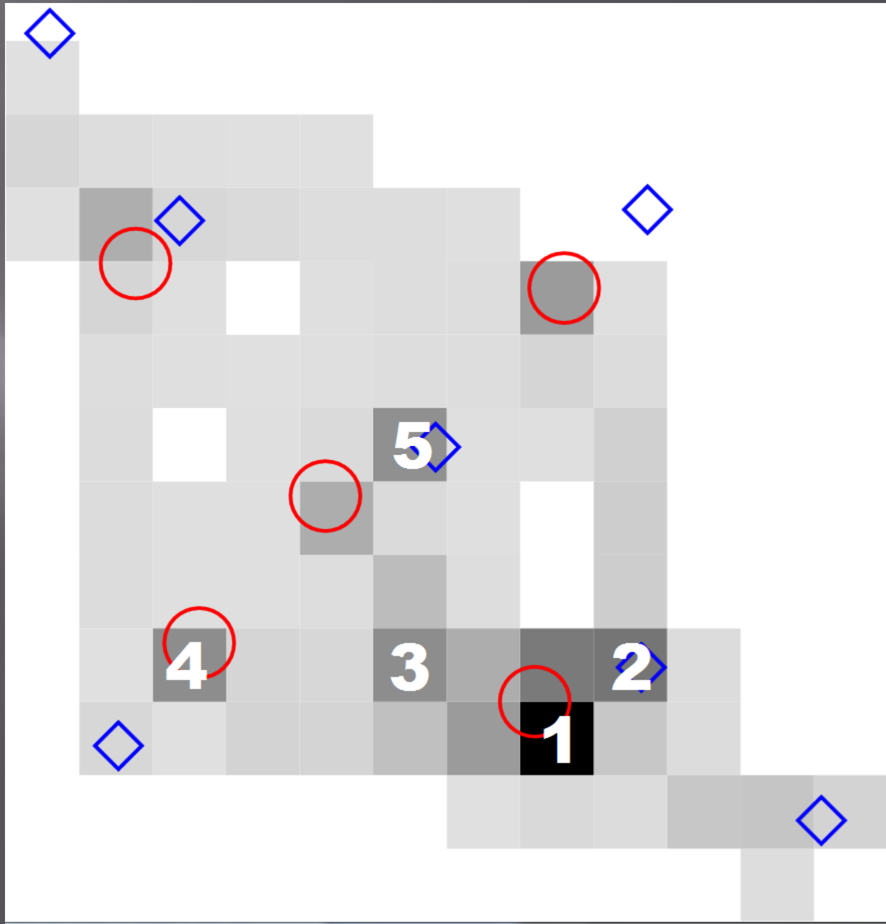
- Expecting:
  - **Hotspots.** Avatars spend most of their time concentrated in a few common areas
  - **Waypoint navigation**. Avatars move along well-defined paths to well-defined destinations
  - **Grouping**. Avatars move together to their destination
    - Avatars start together: this should be a no-brainer

Hotspots

- Determine hotspots by counting seconds spent at each location in the battleground
  - Divide battleground into a grid
  - Sum avatar seconds spent in each cell
  - Cells with highest count are hotspots for that battle
- Hotspots were found where expected, but not in every battle
  - Hotspots typically at flags and graveyards
- Some hotspots on heavy travel paths: ambush!
- Top five hotspots vary battle to battle

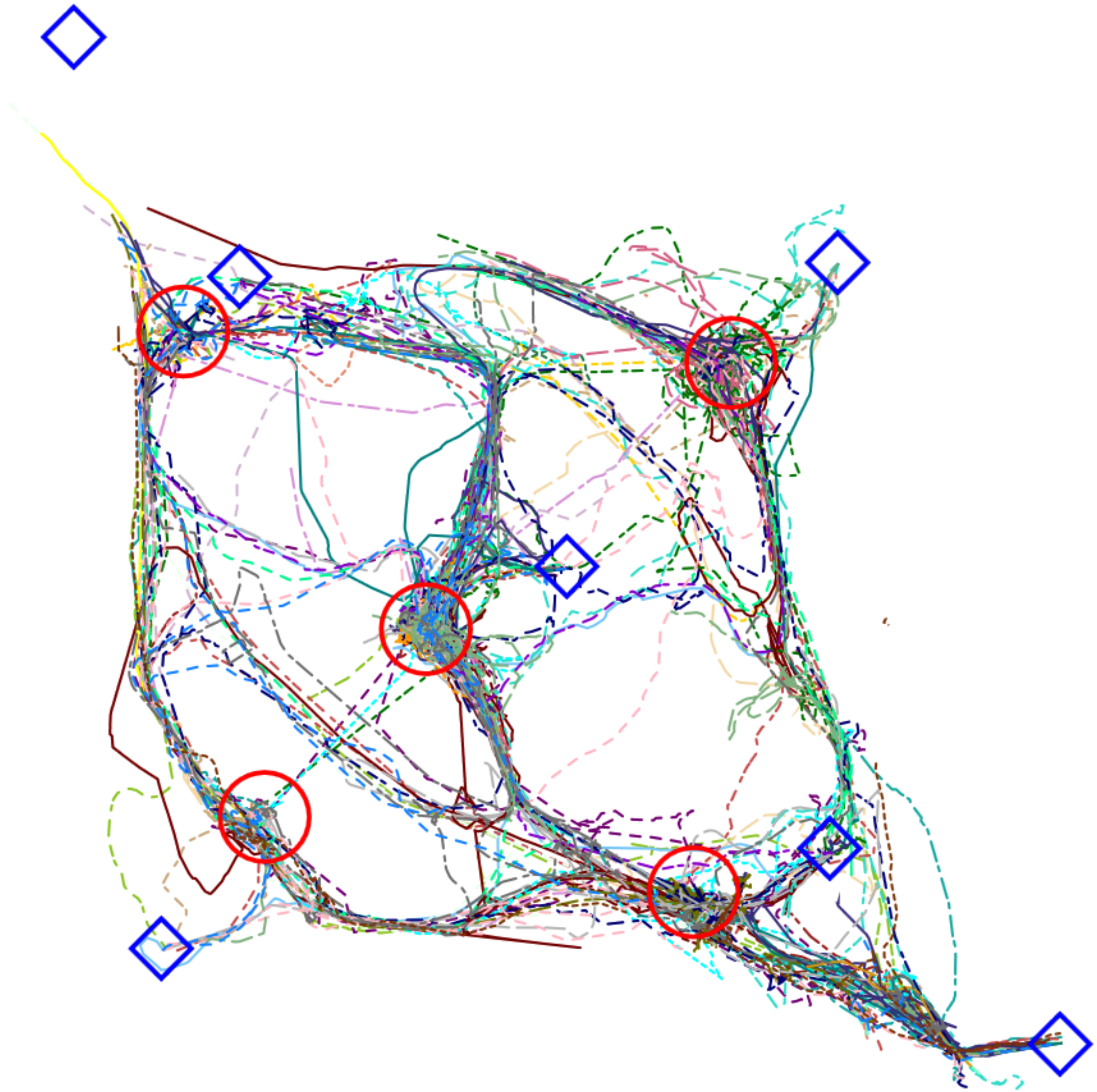
Two battle hotspot examples

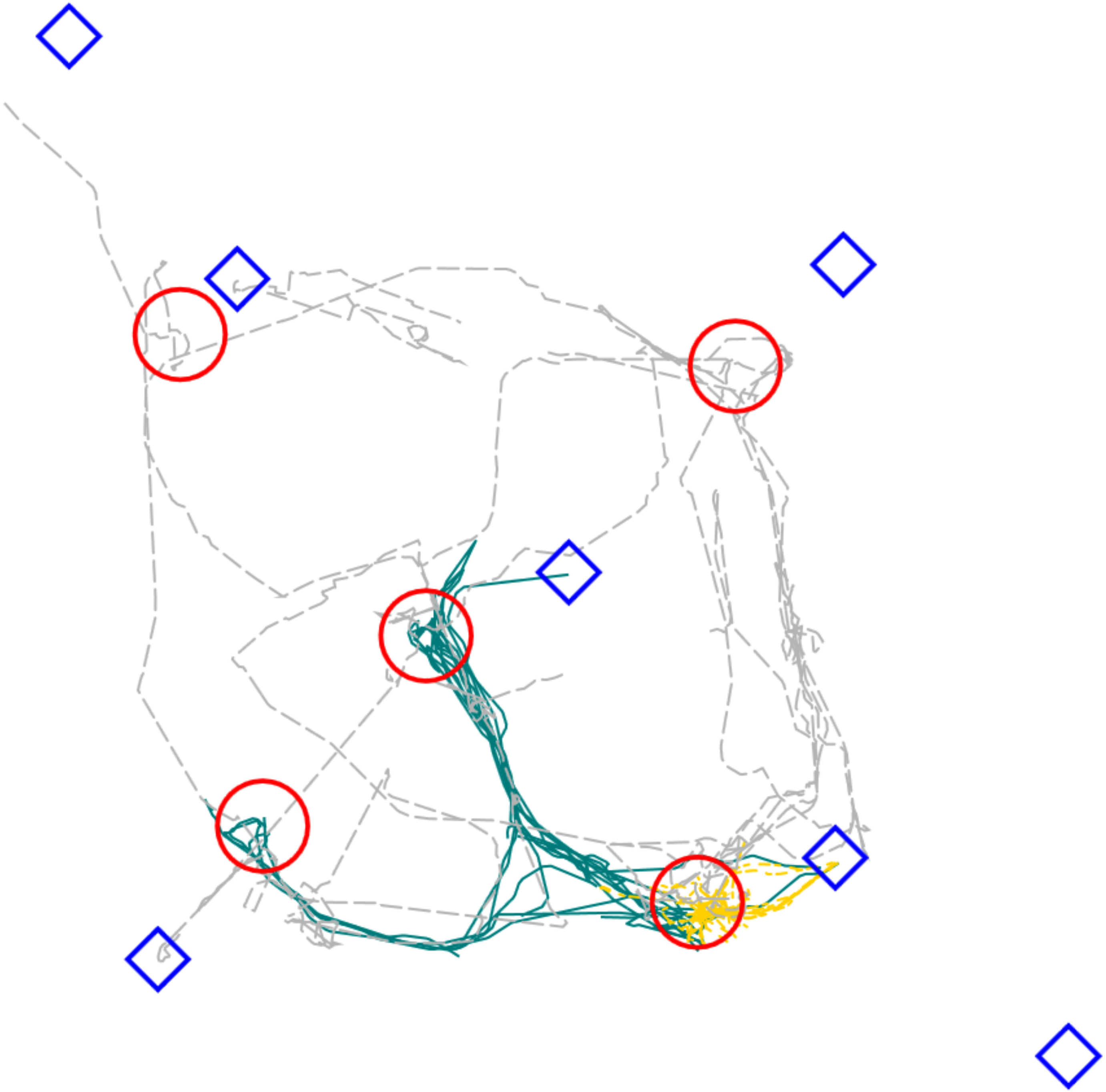




Waypoint Navigation

- Waypoint movement should follow fixed paths
- Movement geographically constrained
  - Avoid water, which slows to 25% of riding speed
  - Cliffs / hills / rivers channel movement
- We found many paths used between hotspots
  - ‘Patrollers’ (16% of avatars) follow waypoints
  - ‘Guards’ (12%) move around a preferred area
  - ‘Wanderers’ (49%) move throughout the map
  - (23% of avatars observed too little to classify)
- Waypoints useful, but not sufficient

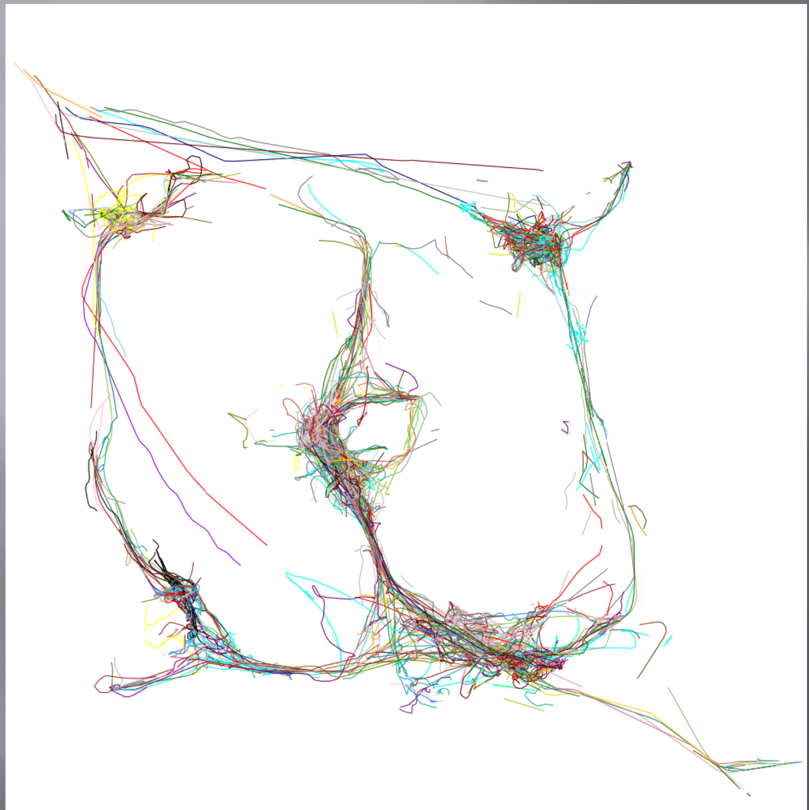




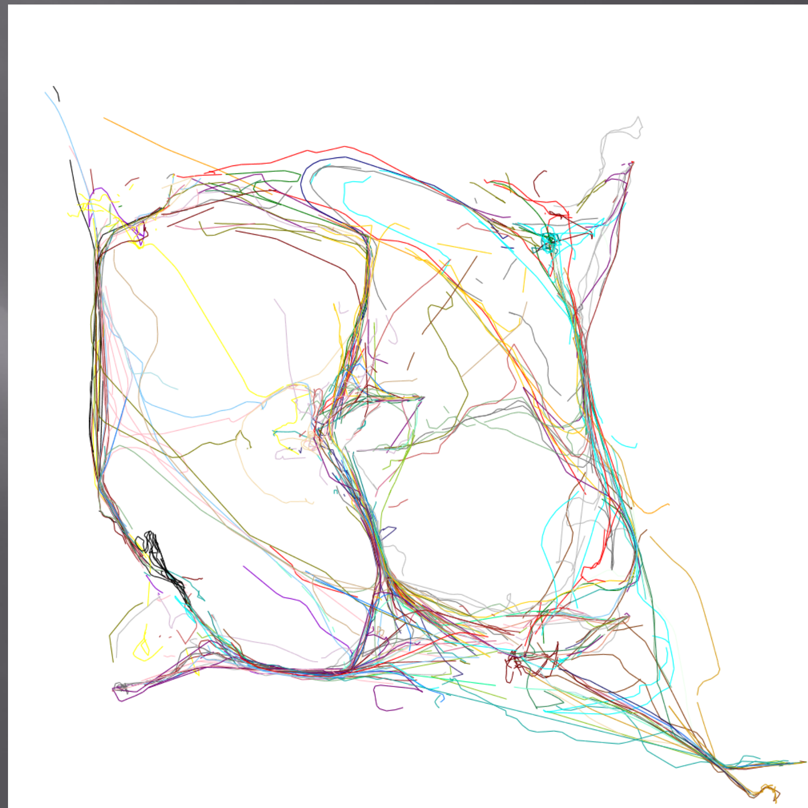
Group Movement

- Logically, Avatars should stick together
  - They start together, and resurrect together
  - Outnumber the enemy to stay alive
- In fact, they seem to go out of their way NOT to stick together
- Analysis: sum up all player seconds where avatar is within 30 yards of another avatar
  - Ideally, should include movement requirement, but this is a much looser / more generous metric.

Affinity trace maps



Affinity Map



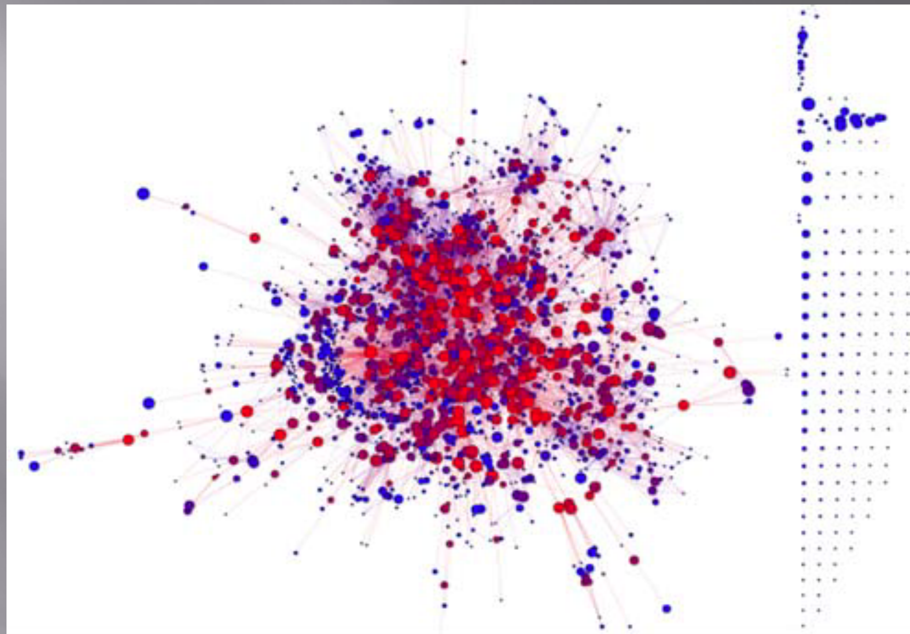
Non-Affinity Map

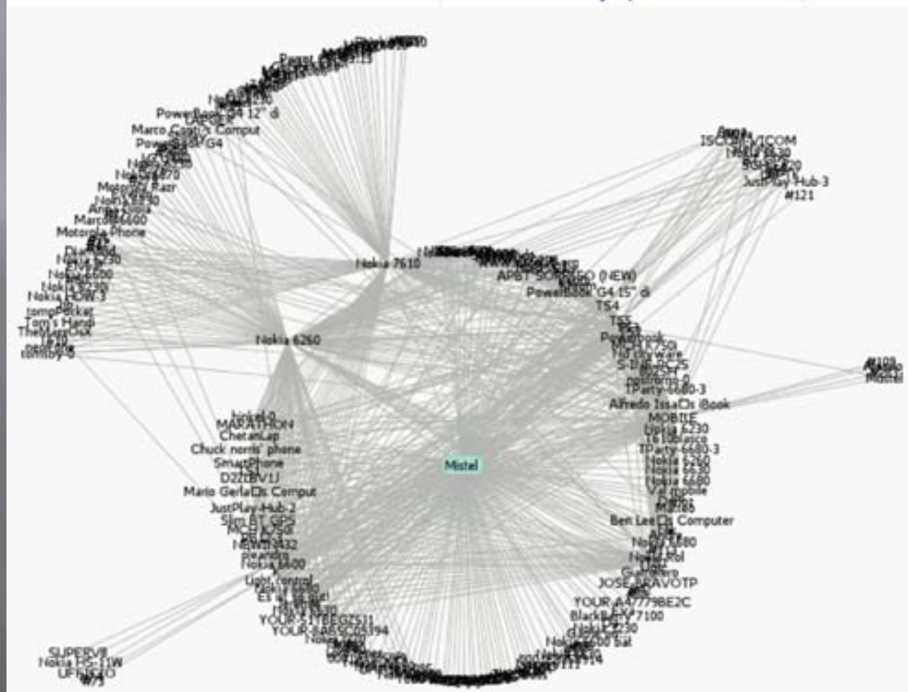
Conclusions

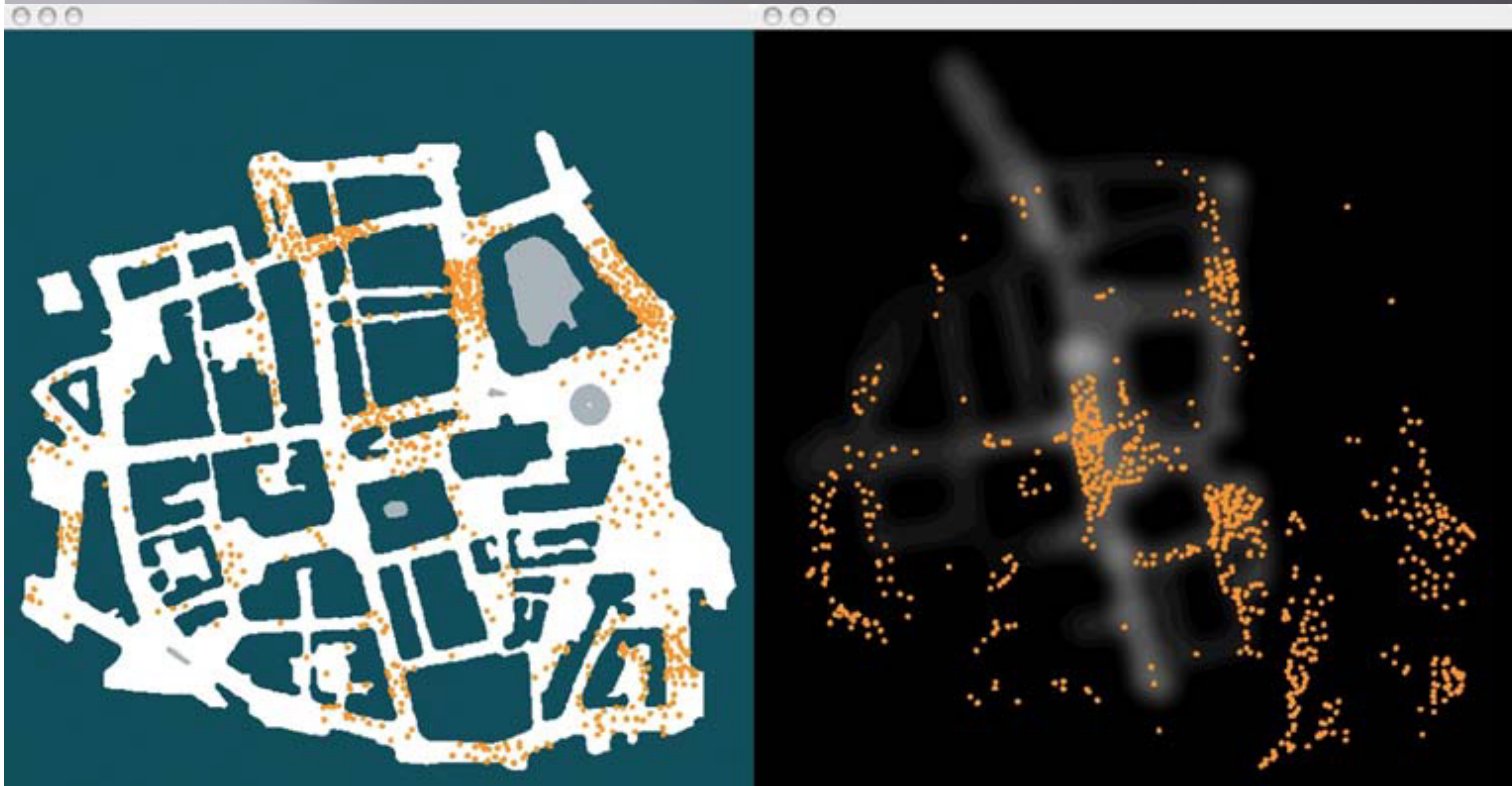
- Existing Avatar movement models insufficient
  - Hotspots useful, but not consistent
  - Waypoints useful for a (small) subset of avatars
  - Grouping / flocking useful for a minority of avatars
- A new synthetic movement model is needed
  - In the meantime, use real data

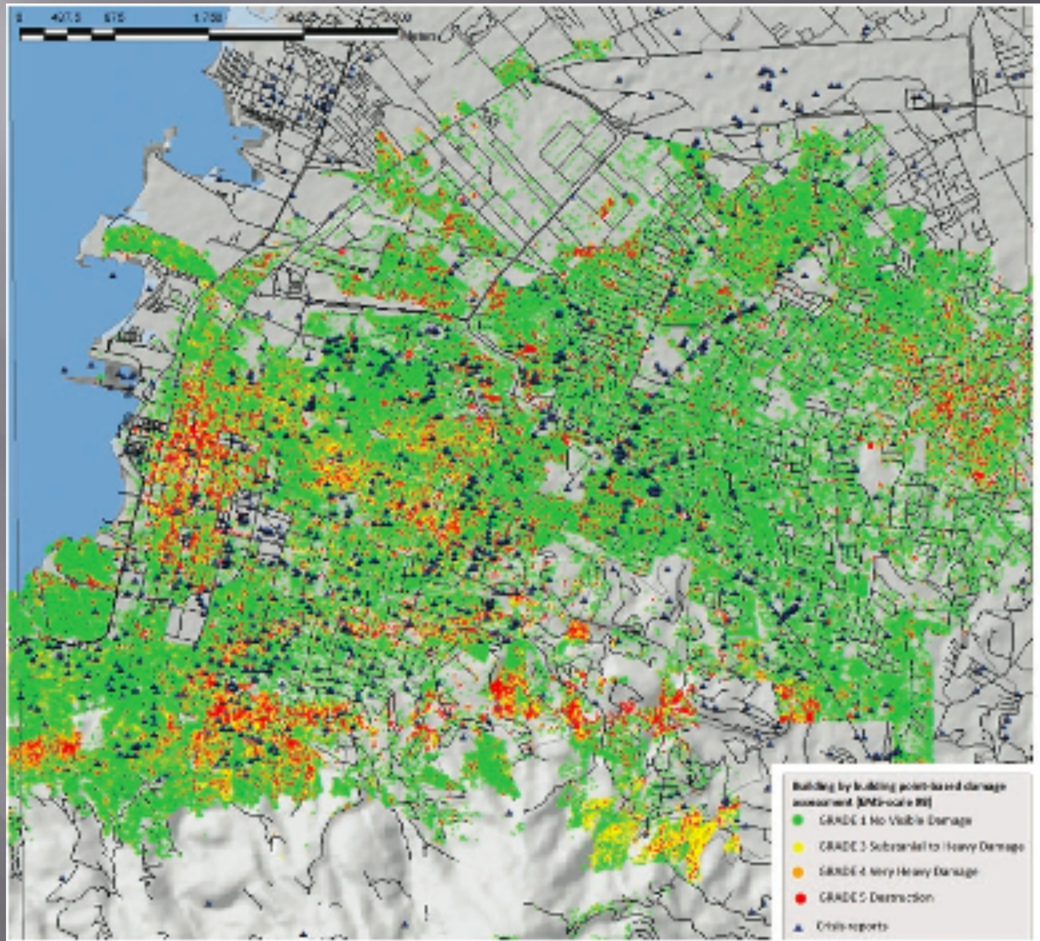
Now what about Social Nets

- Lets look at movement in the real world
- 4 examples –
  - Conference
  - Building
  - Disaster
  - Epidemic

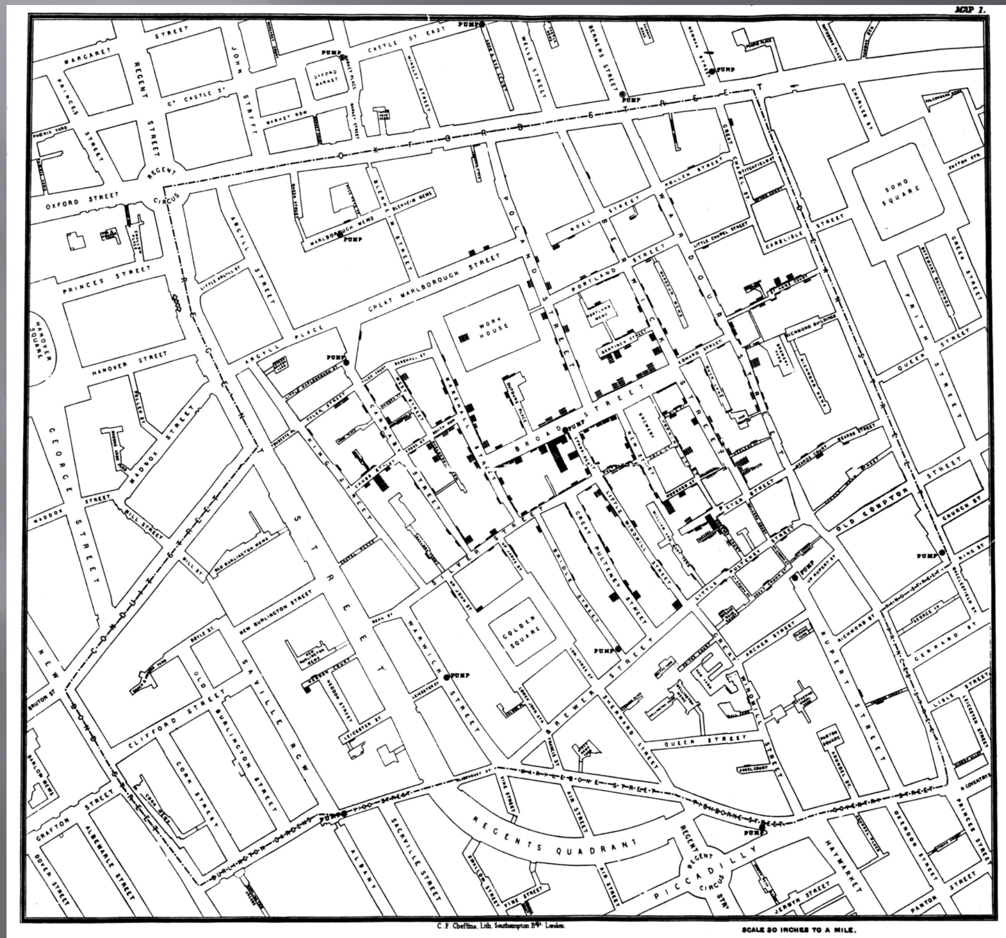



Nokia 7610
Nokia 6260
Mistel
Chuck norris' phone
Motorola Phone
SmartPhone




Building by building point-based damage assessment
GRADE 1 No Visible Damage
GRADE 3 Substantial to Heavy Damage
GRADE 4 Very Heavy Damage
GRADE 5 Destruction
Crisis reports

Ghost Maps



MAP 1.
OXFORD STREET
GREAT MARLBOROUGH STREET
WORK HOUSE
BROAD STREET
GOLDEN SQUARE
SOHO SQUARE
REGENTS QUADRANT
PICCADILLY
REGENT CIRCUS
HAYMARKET
JERMYN STREET
PUMP
C. F. Cheffins, Lith, Southampton Bdgs. London.
SCALE 30 INCHES TO A MILE.

Backup

- Look similar???

Related work

- Pittman / GauthierDickey: "Measurement Study of Virtual Populations" (WoW Census+)
- Suznjevic et. al. "Action specific MMORPG traffic analysis: Case study of World of Warcraft"
- Svoboda et. al. "Traffic Analysis and Modeling for World of Warcraft" (mobile packet traces)
- Thawonmas et. al. "Detection of Landmarks for Clustering of Online-Game Players" (ICE / Angel's Love)
- Chen and Lei – "Network game design: hints and implications of Player Interaction" (ShenZou network traces)
- La and Michiardi – "Characterizing user mobility in second life"
- Liang et al. – "Avatar Mobility in Networked Virtual Environments: Measurements, Analysis, and

Future Work

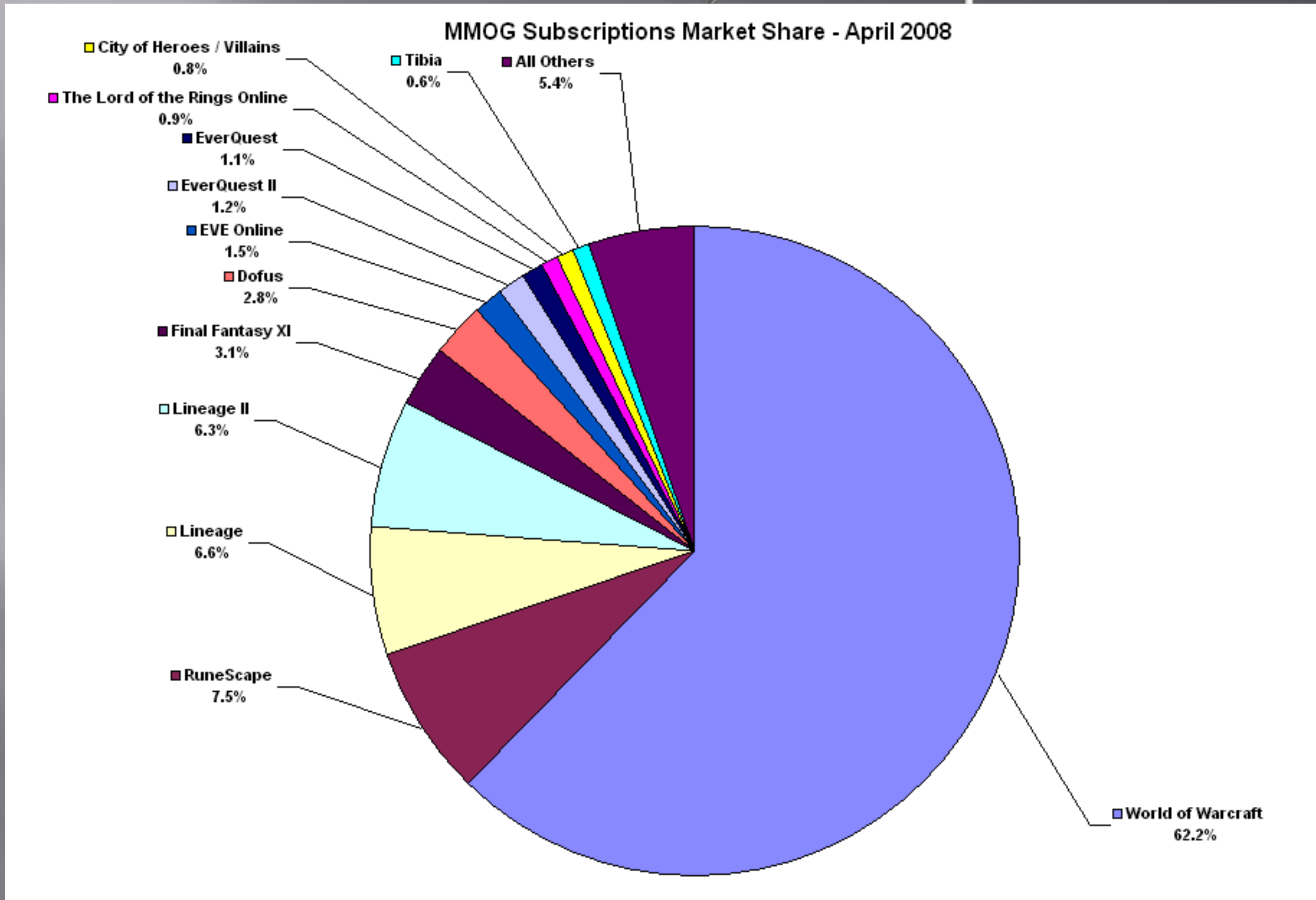
- Further analysis of network traces
  - Message attribution
- Simulate proposed DVE architectures
  - Client-server, application-layer multicast, mesh
  - Aggregation / per message transmission
- Capture Wintergrasp data
  - Most challenges are practical, not technical

- Contact me for access to anonymized traces: *johnmil@microsoft.com*

WoW Battlegrounds

Battleground	Players	Type
Warsong Gulch	20	Flag Capture
Arathi Basin	30	Territory
Alterac Valley	80	Kill the General
Eye of the Storm	30	Territory + Flag Capture
Strand of the	30	Assault
Isle of Conquest	80	Kill the General
Wintergrasp	240	Assault

Wow Market Share, ca. April 2008



Source: www.mmogchart.com/Chart7.html (Bruce Woodcock)

THE NEAR-TERM (IN) FEASIBILITY OF P2P MMOG'S

2. John L. Miller and Jon Crowcroft

From NetGames 2010

Outline

- Motivation
- Data Capture and Processing
- Operational Assumptions
- Simulator
- Results
- Conclusions

Paper Motivation

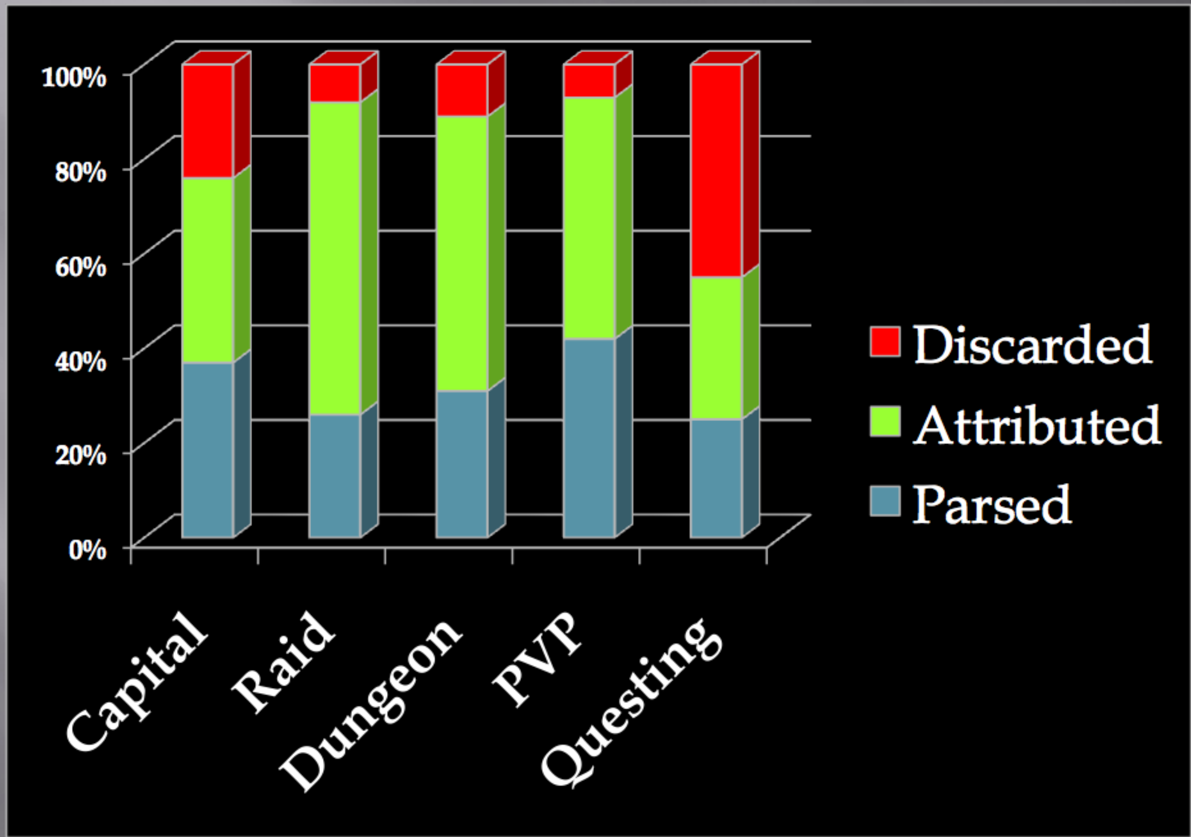
- Challenges in DVE's well known
  - Scalability, latency, security
- Lots of great proposals, especially P2P
  - No significant adoption. Why?
- →Search real examples for answers
  - World of Warcraft or Second Life
  - Realistic network conditions
    - Everything works differently in the real world

Data Acquisition

- Getting network traces is hard
  - Players are (rightly) paranoid
  - Even online affiliation provided little incentive
- Interpreting network traces is hard
  - WoW protocol is pithy and partly secured
  - Mitigation: internet is a treasure trove of information

- End result: simulation input traces which include:
  - Avatar position, movement, and some activities
  - 'Attribution' of most message bytes which were not successfully parsed
  - Non-parsed, non-attributed bytes discarded

Data Parsing Results



Categories as proposed in earlier research, e.g.
Suznjevic, Dobrijevic, Matijasevic, 2009

Operational Assumptions

- Residential players with typical broadband
  - Actual, not advertised speeds
- Messages
  - Originate at 'sender' Avatar position
  - Transmitted by originator to each receiver
- Propagation determined by Area of Interest (AoI)
  - (Optimistic) perfect, zero-cost knowledge available
- Transport is TCP/IP
  - Guaranteed once, in-order message delivery

Node Profiles from

Figure 4.3 UK residential broadband connections by headline speed, April 2009

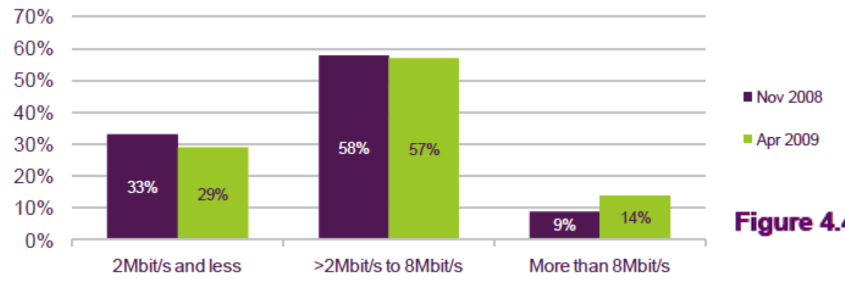


Figure 4.4 Average UK broadband speeds, April 2009

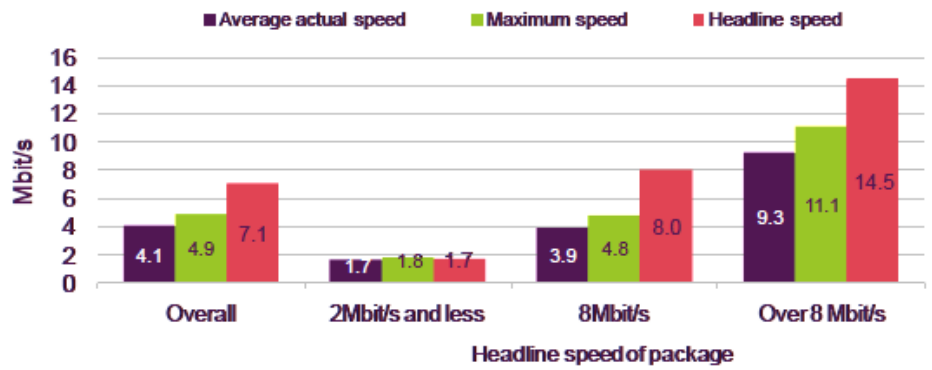
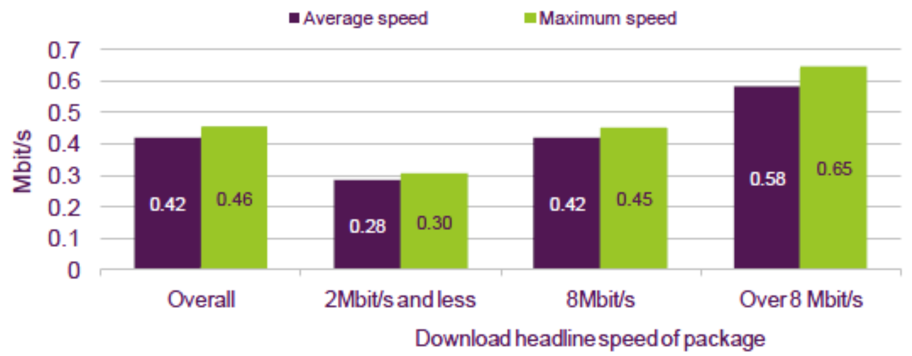


Figure 8.2 Average and maximum upload speeds, April 2009



Ofcom
OFFICE OF COMMUNICATIONS

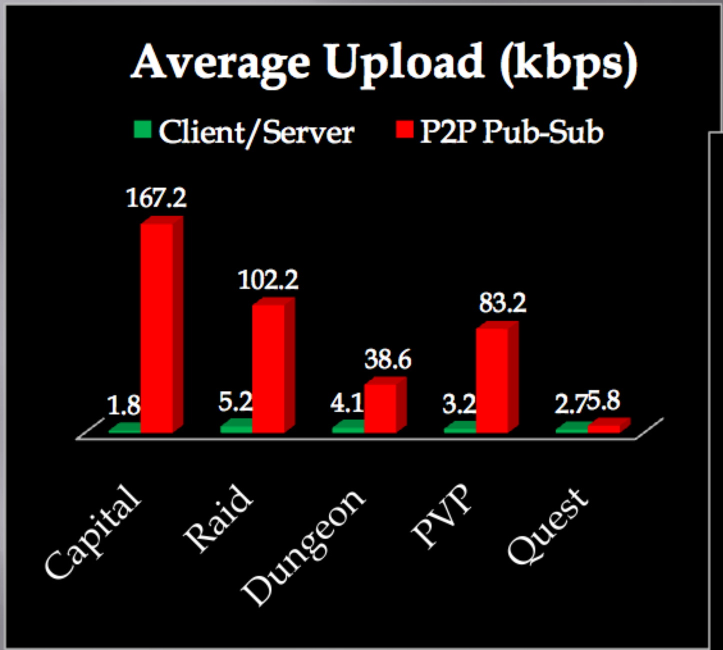
Simulator

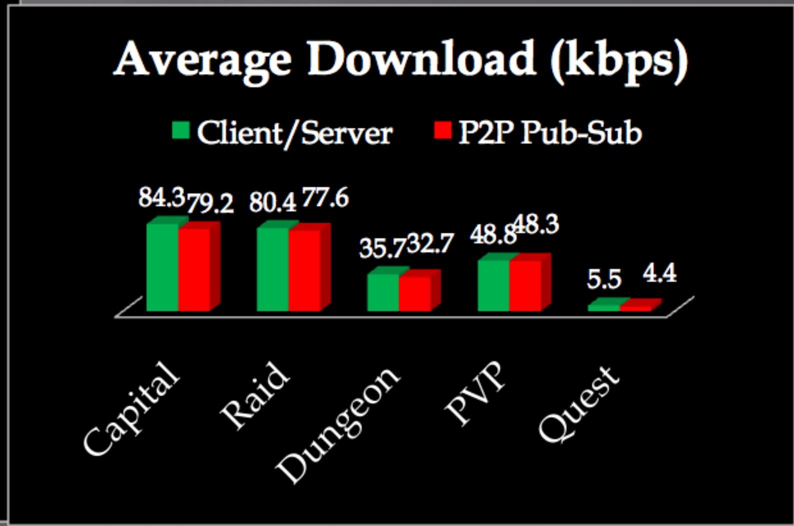
- Accepts our WoW simulation traces as input
- Time resolution: 1 millisecond
- Includes modelling of
  - TCP Windowing, packet framing
  - Last hop uplink, downlink capacity and contention
  - Latency
- Node bandwidth assignments based upon OfCom 2009 UK survey

Results

- Even without overhead, P2P protocols consume too many resources
  - For intense scenarios, nodes can 'fall behind'
  - Most messages important and difficult to discard
- 'Falling behind' increases node load
  - new messages + catch-up
- Aggregation of messages useful
  - Introduces sender delay
  - Offset by fewer bytes to transmit

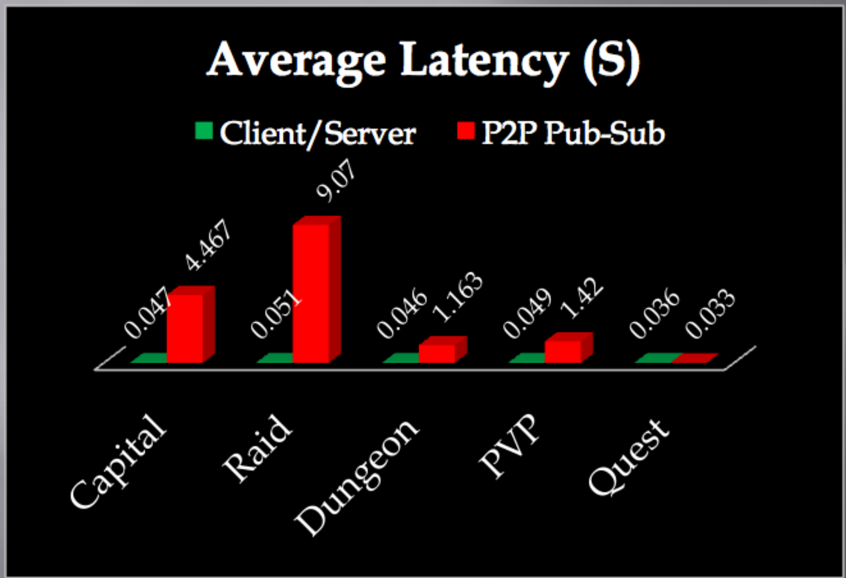
Results: Bandwidth

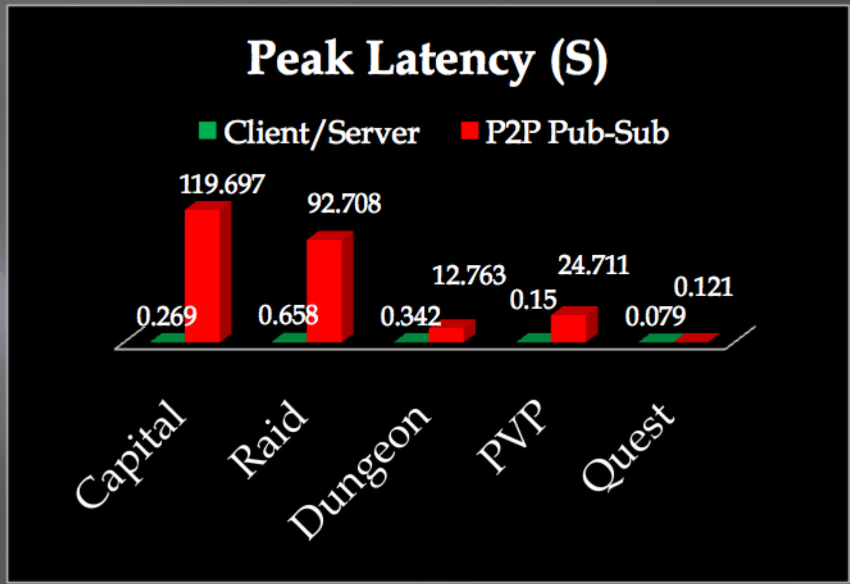




- P2P Upload bandwidth scales with number of peers in AoI, 10 x to 100 x the Client-server load on average
- Client-server Download slightly larger because nearby AI is communicated from server rather than locally calculated

Results: Latency





- Latency is usually a function of message creation, upload bandwidth, and neighbors
- Average latency OK with small number of neighbors, but as expected, scenarios with large number of neighbors and high message rates have highest latency
- Differences from Client: server: Ignoring questing, 40:1 to 445:1

Message Aggregation

- Message aggregation: bundling together time-proximate messages to send together
  - Reduces overhead by up to a factor of 10
- Delays message transmission, but mitigated by shorter transmission time and smaller transmission queue

- Note: some ‘bundling’ artifacts in traces
  - Many message types lack internal timestamp, so we used capture time as timestamp
  - Wow client-server does some aggregation, biases our measurement with bundles of messages

P2P Message Aggregation

Impact of 1 millisecond of aggregation on **average** latency measurements, relative to original measurements

	Upload Bandwidth	Download Bandwidth	Latency
Capital	-6.50%	-7.10%	-22.30%
Raid	-34.30%	-35.70%	-76.90%
Dungeon	-28.80%	-29.00%	-60.20%
PVP	-17.50%	-18.60%	-52.50%
Quest	-10.20%	-13.60%	2.20%

Client-Server Aggregation

Impact of 1 millisecond of aggregation on **average** latency measurements, relative to original measurements

	Upload Bandwidth	Download Bandwidth	Latency
Capital	-25.00%	-31.80%	0.80%
Raid	-6.10%	-17.70%	0.20%
Dungeon	-17.60%	-20.40%	0.60%
PVP	-31.70%	-38.60%	-0.30%
Quest	-9.00%	-14.30%	0.00%

Conclusions

- P2P wow-like MMOG's are not feasible with today's residential broadband
  - Hybrid solutions *may* be possible
- Message aggregation useful
  - Reduce bandwidth and in many cases latency

- Future work:
  - Recommend focus on non-P2P solutions
  - Identify 'average' node attributes required to support P2P

How do P2P OSNs do?

- 3 main attempts
- Diaspora, Peerson and Safebook
- Complexity is high
- Reliability is low
- Downlink capacity not, yet, a problem, compared to games
- Gamers (FPS) have to cope with field of view/realestate, so natural limit on total players
- C.f. regions in first part of talk, gives scale
- Would same region idea work for OSNs
- i.e. spatial affinity in real world, for relevance
- Research (out there recently) says YES!

Take Home

1. We're not there yet…
2. Server based systems for many-to-many Games and OSNs
   1. +ve ordering/cheat proofing
   2. +ve mix/filter
   3. -ve scale of server
   4. -ve control/privacy
3. With fiber roll-out happening, this will work (as well as lower latency)
4. Using Affinity for relevance filtering in OSN update traffic could work too☺