A Report on the Project Darkstar Anthropological Expedition Into the World of Massively Scaled Online Games

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A Preliminary Report from the Darkstar Anthropological Expedition Into the Unexplored Jungle of Massive Multi-Player On-Line Games

MMOs Are Different

- Different roles
  - Producers
  - Artists
  - Coders
- Different goals
  - Fun
  - Cool
- Different organizations
  - Publishers
  - Production houses

What We Look Like

What They Look Like


WORLD
WARCRAFT
WRATH of the LICH KING
BLIZZARD
ENTERTAINMENT
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Swan Lake
Barbie

The Numbers Are Staggering

World of Warcraft

- Approximately 10 million subscribers
  - Average subscription : $15/month
  - Average retention : two years +
  - $150 million per month/$1.80 Billion per year run rate
  - For one game (they have others)
- Unknown number of servers
- ~2,700 employees world wide
- Company is changing
  - Was a game company
  - Now a service company

Webkinz

- Approximately 5 million subscribers
  - Subscription comes with toy purchase
  - Subscription lasts one year
  - Average 100k users at any time
  - Currently only US and Canada; soon to be world wide
  - Aimed at the 8-12 demographic
    - And their mothers...
- The company is changing
  - Was a toy company
  - Becoming a game/social site company

Cultural Observations

- Games are part of the entertainment industry
  - Producers, daily rushes, story lines
  - Fun/engagement most important
- The default computing environment
  - A PC or console
  - One thread
  - One player
- Scaling and reliability have never been vital
- Low latency, not total throughput
- Not a traditional “IT” market

Riding Moore's Law

- When processors get faster
  - Games play faster
  - Things can be more complex
- When GPUs get faster
  - Better visuals
  - More engaging play
- Games machines are supercomputers

On-Line Games Change Everything

- Scale and reliability needed
  - One call to customer service = ~3 months subscription
  - Slow games are not fun
  - Server crashes impact multiple players
- Capacity management is hard
  - Hit games need to scale up
    - Sometimes faster than human time
  - Duds need to scale down
- Chip architectures are changing
  - Threads, not clocks

Current Scaling Techniques

- Geographic Decomposition
  - One server = some geographic area
    - Island
    - Room
  - Need to decide scale during production
  - Get it wrong, game play impacted
- Shards
  - Copies of the game world
  - Allow multiple people to do the same thing
  - No communication between shards
    - Bad for guilds

Reliability Techniques

- Snapshots
  - On occasion, dump state to a database
    - Dumping state sucks cycles
    - Done during transitions (run the video...)
    - May not happen frequently
- Otherwise, state kept in memory
  - Faster access
  - Lost if the server is lost
- Considerable game play can be lost

The New Environment

- Multi-core machines
  - Clocks aren't getting faster
  - Cores are multiplying
  - Only works for highly concurrent programs
- Highly distributed
  - Need servers to work together
  - Need to be able to dynamically scale

Project Darkstar Goals

- Support Server Scale
  - Games are embarrassingly parallel
  - Multiple threads
  - Multiple machines
- Simple Programming Model
  - Multi-threaded, distributed programming is hard
  - Single thread
  - Single machine
- In the general case, this is impossible

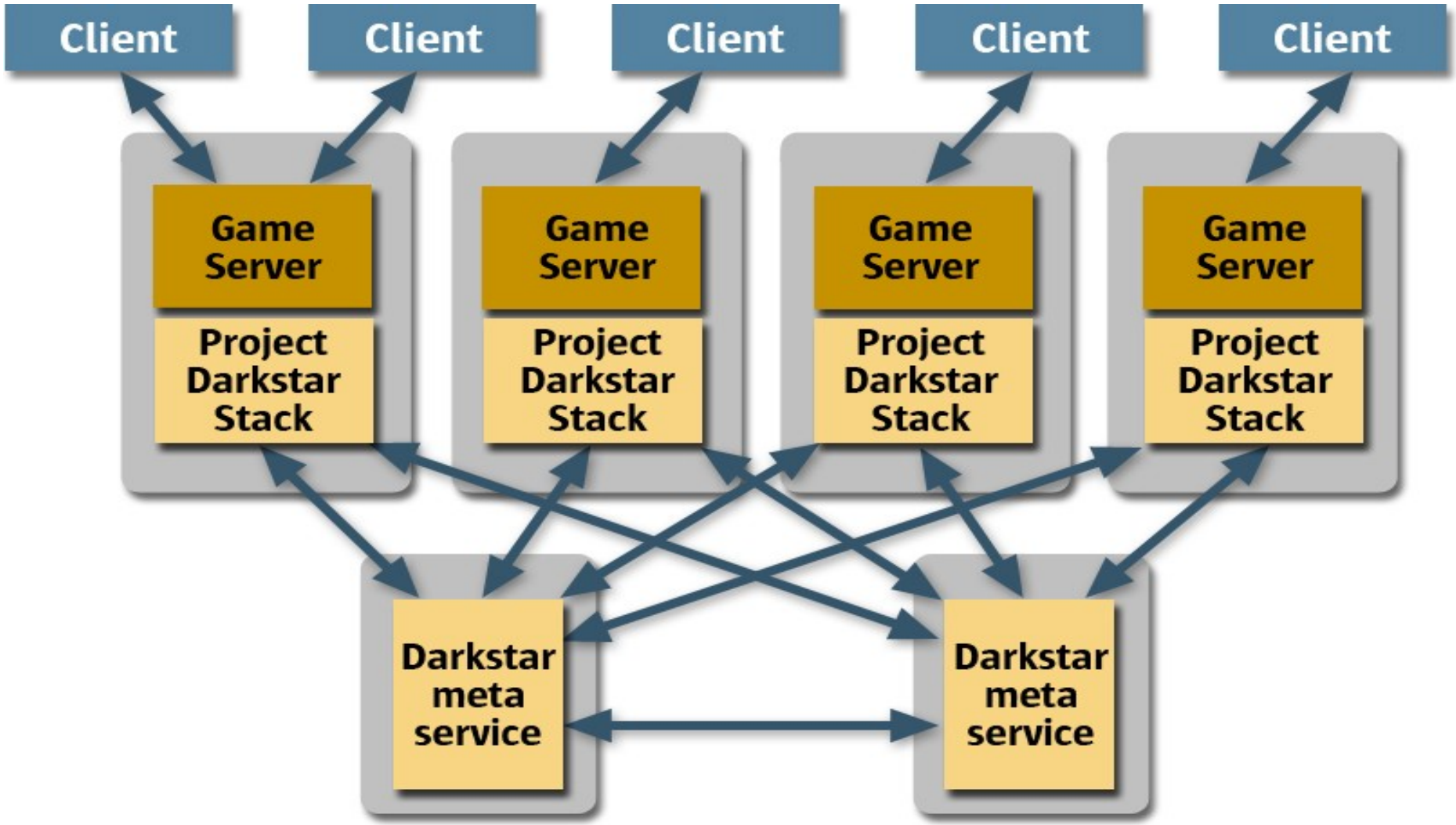
The Special Case

- Event-driven Programs
  - Client communication generates a task
  - Tasks are independent
- Tasks must
  - Be short-lived
  - Access data through Darkstar
- Communication is through
  - Client sessions (client to server)
  - Channels (publish/subscribe client/server-to-client)

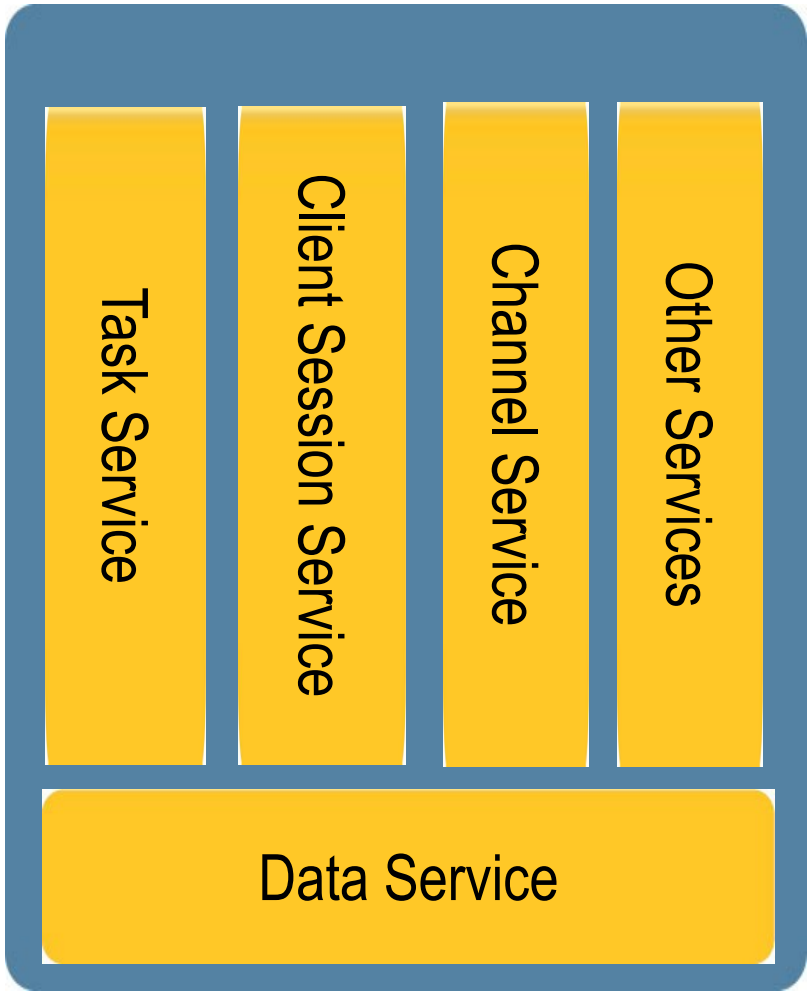
Game Architectures

- Powerful clients
  - Lots of graphics
  - Lots of state
- Simple servers
  - Abstract model of the world
  - Does as little as possible
- Communication protocol
  - Small messages
  - Best guess then repair
  - No peer-to-peer

Project Darkstar Architecture



Stack Architecture



Dealing with Concurrency

- All tasks are transactional
  - Either everything is done, or nothing is
  - Commit or abort determined by data access and contention
- Data access
  - Data store detects conflicts, changes
  - If two tasks conflict
    - One will abort and be re-scheduled
    - One will complete
- Transactional communication
  - Actual communication only happens on commit

Project Darkstar Data Store

- Not a full (relational) database
  - No SQL
  - Assumes approximately 50% read/50% write
- Keeps all game state
  - Stores everything persisting longer than a single task
  - Shared by all copies of the stack
- No explicit locking protocols
  - Detects changes automatically
  - Programmer can provide hints for optimizations

Project Darkstar Communication

- Listeners hear client communication
  - Simple client protocol
  - Listeners established on connection
- Client-to-client through the server
  - Allows server to listen if needed
  - Very fast data path
- Mediation virtualizes end points
  - Indirection abstracts actual channels

Dealing with Distribution

- Darkstar tasks can run anywhere
  - Data comes from the data store
  - Communications is mediated
  - Where a task runs doesn't matter
- Tasks can be allocated on different machines
  - Players on different machines can interact
  - The programmer doesn't need to chose
- Tasks can be moved
  - Meta-services can track loads and move tasks
  - New stacks can be added at runtime

The End Result

- Simple and familiar programming model
  - A single thread
  - A single machine
- Multiple threads
  - Task scheduling part of the infrastructure
  - Concurrency control through the data store, transactions
- Multiple machines
  - Darkstar manages data and communication references
  - Computation can occur on any machine
  - Machines can be added (or subtracted) at any time

Current Status

- Multi-node version available
  - Open source (GPLv2)
  - Commercial license under development
- Working on performance, reliability
  - Caching data
  - Failure recovery
  - Add/delete nodes

Current Questions

- Characterizing workload
  - Games are secretive
  - Makes it hard to know performance
- Data access break-even point
  - Memory access is always faster
  - Data store allows multiple machines
  - When do we get the same/better performance
    - Maybe never

How Much Can Be Hidden

- Lots
  - No explicit locking
  - No need to identify critical sections
  - Looks like single-threaded code
- But not all
  - Data design for concurrency

Is It Computer Science?

- Important questions around
  - Concurrent programming
  - Reliable systems
  - Dynamic distributed systems
- Not the answer, but an answer
- And it is fun...

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