



Change R...

### Breaking News

Scheduled maintenance will be on Wednesday, 1st February from 03:00 (CET) until 07:00 (CET). During this time, the game will be unavailable for play.

Please follow @BlizzardCSEU\_EN on Twitter for updates.

# SAiP World of Warcraft

Thanks to Magnus  
a.k.a. "Kelthanox"

Kelthanox

Enter World



Shop

AddOns

Menu

Gildintor  
Level 10 Mage  
Stormwind City

Kelthanox  
Level 70 Warrior  
Valdrakken

Stegonaar  
Level 70 Death Knight  
Valdrakken

Sarzaim  
Level 70 Shaman  
Valdrakken

Xylium  
Level 70 Druid  
Lunarfall

Exoruun  
Level 62 Paladin  
Valdrakken

Infernace  
Level 60 Demon Hunter  
Valdrakken

Keltzhong  
Level 62 Monk  
Valdrakken

Anandruil  
Level 63 Rogue  
Valdrakken

Vekardril  
Level 61 Hunter  
Valdrakken

Kelviks  
Level 62 Warlock  
Valdrakken

Create New Character

Delete Character



Tutmosis 100% 180/1000  
Master Shang Xi 100% 5:502

Master Shang Xi

**THE LESSON OF STIFLED PRIDE**  
Facing a living opponent is a very different thing from the stationary targets in the yard. Living opponents strike back. There is the very real fear of failure, and sometimes, even death.

You must have the courage to overcome those fears.

Challenge the other trainees within the temple or down the steps below, and defeat them.

**QUEST OBJECTIVES**  
Defeat 6 Huojin Trainees or Tushui Trainees.

**REWARDS**  
You will receive:  
Initiate's Belt

You will also receive: 1  
Experience: 520

Accept

Master Shang Xi

My 'a bit more humble' monk level 1 😊

Congratulations, you have reached **[Level 2!]**  
Reputation with Shang Xi's Academy increased by 250.  
The Lesson of the Sandy Fist completed.  
Experience gained: 520.  
Received 1 Silver.  
You receive item: [Initiate's Bracers]  
Quest accepted: The Lesson of Stifled Pride

XP: 280/900

Shang Xi Training Grounds

09:26

Quests

The Lesson of Stifled Pride  
0/6 Sparring Trainees defeated

Backpack

Search

1 15

2 43



- **MMORPG:**
  - Massive multi-player on-line role playing game
- **RPG:**
  - you assume the role of a character in a virtual world and control its actions
- **MMO:**
  - You play on-line with massive amounts of other players



# Example: Kelviks in Valdramken





# Blizzard's WoW

- At its peak around *12 million subscribers*
  - 5.5 million subscribers Nov 2015
    - Last official report 😊
      - More fun to report numbers going up than down...
- Our challenge today
  - Design It 😊

Today, the WoW architecture shows its age, but still, the requirements are challenging.



# Gfx requirements

- A highly detailed 3D world must be rendered on my computer screen.





# Gfx requirements

- A highly detailed 3D world must be rendered on my computer screen.







# The World is Big – and *Growing*

AARHUS UNIVERSITET

- Zooming out – and out...



2012



2023







# A bit of numbers

- Magnus views
  - 1920 x1080 pixels of 32 bit color depth
  - 60 frames per second [mine said 100 fps, but...]
- 1920x1080x4 bytes = 8.294.400 bytes
- 60 frames = ~ **498 Mbytes per second**
  - $4,98 \times 10^8$  bytes/second

# Massive Multiplayer Online

Thodiusprime the Darkener

<Four Zero Four>

Vranensh  
<WhiteKrales>  
Dragonslayer Sivik  
Uinaan the Darkener  
<The Midnight Order>  
Vendryk <The Darkener>

Go tank the Faceless One

<Underskattad>

Dragonlayer Thrick  
<Steadfast>

ederia  
<adfa>

Bucky the Kingslayer

<Jontes Cobres>

Esteemed Kabann

<Jontes Cobres>





# MMO Requirements

- You see and can interact with all other characters in the same location.
  - No fighting but movement, chatting, trading, ...
- That is: what you see on your screen potentially depends upon the actions of 5.500.000 online players.
  - (Not quite, but...)



# A naïve Software Architecture

- ***Software Architecture is the tool to tame such a beast.***
- One proposal:
  - One very large machine at Blizzard
    - Contains full world and all players, inventory, weapons, ...
    - Generate 60 fps for 5.500.000 players
  - One very high bandwidth network
    - Transport  $5,5 \times 10^6 * 4,98 \times 10^8$  byte/s =  **$2,74 \times 10^{15}$  byte/s**
  - Then 5.500.000 clients...
    - ...receives 60 fps second.
- Conclusion: Nay...

2.200.000 Gbit/2 ???





# Quest: Make the Architecture

- At the end, two groups *volunteer* to give a 10 minute presentation of their answers to:
- What do I want?
  - What computers are involved?
    - Server(s), clients, peers,
  - What are the responsibilities of each piece of software on the particular type of computer?
  - Where is state stored? Player, landscape, weapons?
  - What is communicated over network?



# Be Happy 😊 - It is fun!

- Blizzard and other companies have spent years on this, so do not despair...
  - Unless you know the architecture, it is difficult
- No grades will be given 😊
- Our Pedagogical Goal today
  - Discuss, question, motivate *tools to do the job!*
  - Get acquainted with fellow students
    - Maybe form a group to continue work, or seek the company of others 😊