Game Technology

Lecture 12 – 23.01.2015

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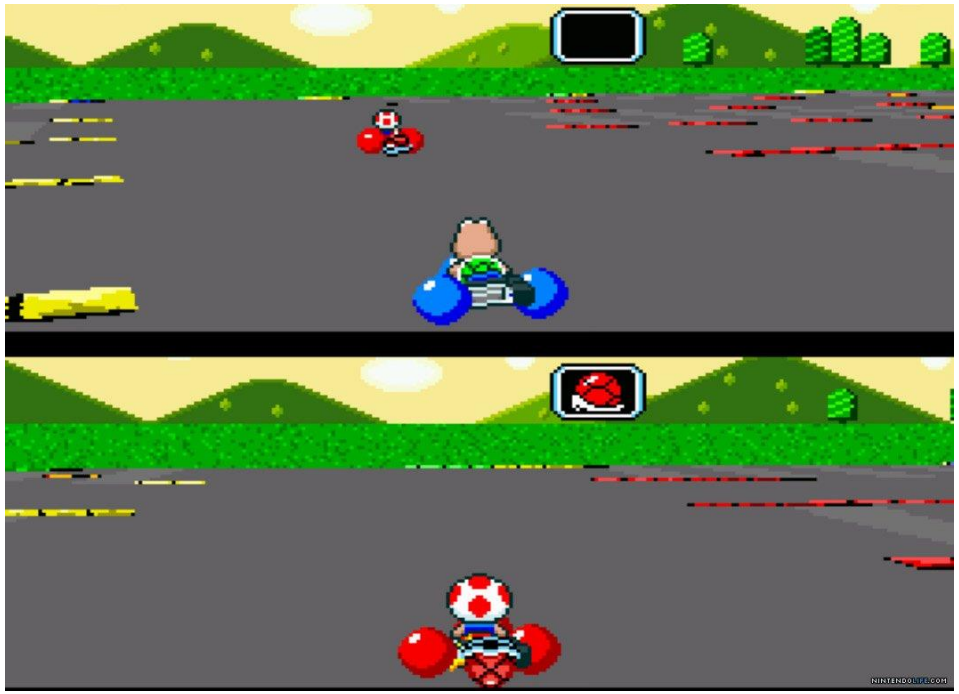

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Preliminary timetable

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Lecture No.	Date	Topic
1	17.10.2014	Basic Input & Output
2	24.10.2014	Timing & Basic Game Mechanics
3	31.10.2014	Software Rendering 1
4	07.11.2014	Software Rendering 2
5	14.11.2014	Basic Hardware Rendering
6	21.11.2014	Animations
7	28.11.2014	Physically-based Rendering
8	05.12.2014	Physics 1
9	12.12.2014	Physics 2
10	19.12.2014	Procedural Content Generation
11	16.01.2015	Compression & Streaming
12	**23.01.2015**	**Multiplayer**
13	30.01.2015	Audio
14	06.02.2015	Scripting
15	13.02.2015	AI


KONAMI
THE SIMPSONS
KONAMI
The Simpsons
ATTACK
JUMP

One computer, multiple players

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Trivial implementation

No latencies

Uncompressed realtime 3D video chat

Saturn Bomberman

Local multiplayer

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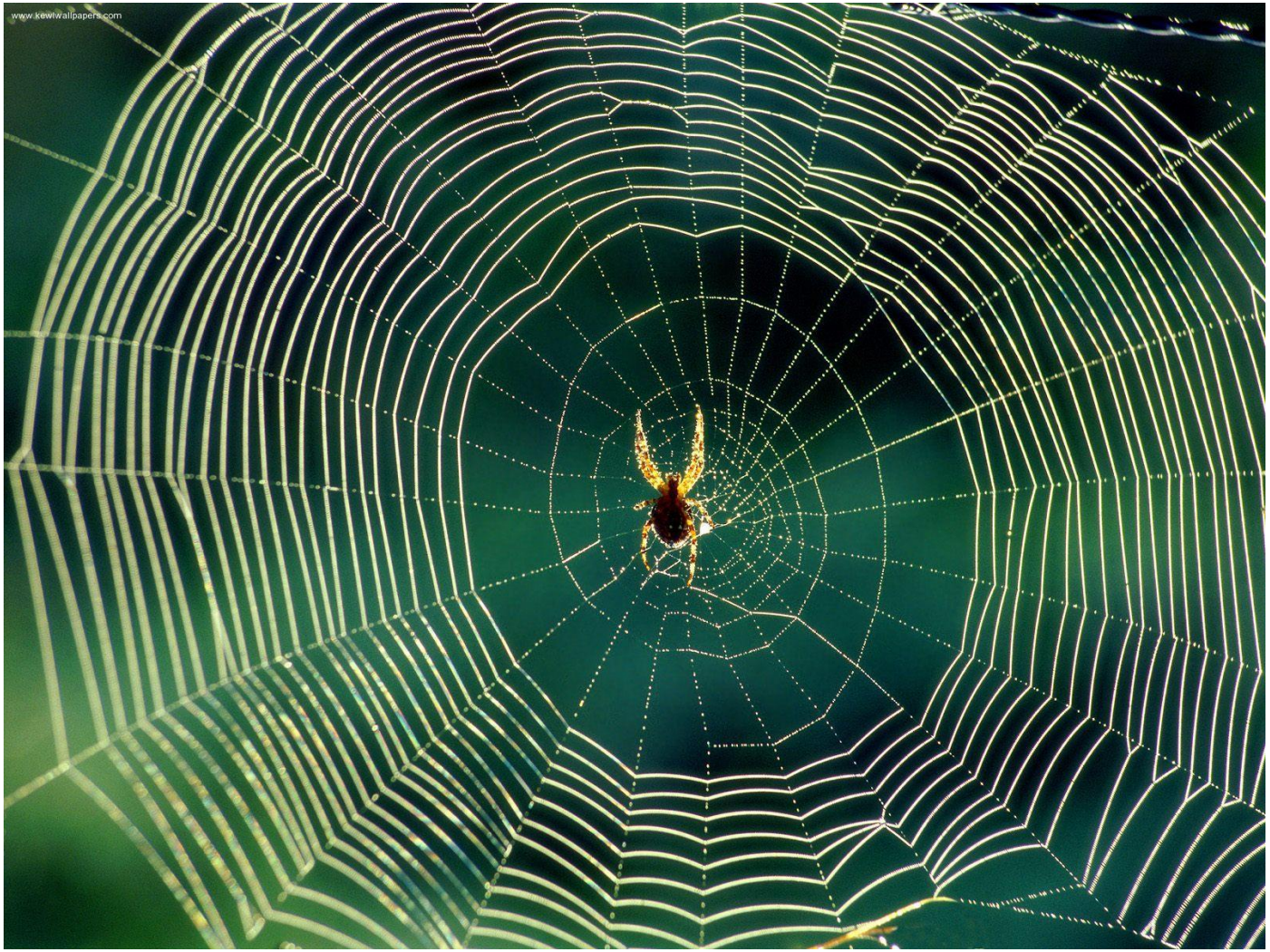
Screen space restricted

Number of controllers restricted

Number of locally available players who understand Bomberman severely restricted


www.kewlwallpapers.com

Peer-to-Peer Lockstep

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Synchronizes game step by step

- Send command data (go forward, move unit,…)
- Receive commands by all other players
- Simulate game step on all computers
- Repeat

Pro & Contra

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Low data rate

- Just high level game commands

Very fragile

- Requires complete determinism
- Requires every client to reliably send data
  - One client hangs -> the game hangs

Maximizes latency

- Game has to wait for every one

Players can‘t join a running game

- Would have to rerun all previous game commands

Determinism

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Randomness

- Save your seeds
- Implement your own rand()
- Done

Calculations

- Integer calculations - easy
- Floating point calculations – a little weird
  - Different optimizations on different compilers
    - There is usually a „strict IEEE 754“ option
  - Different CPUs
    - x86 calculates in 80bits, then rounds to 32/64 bit
  - …

Peer-to-Peer Lockstep Today

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Still used in strategy games

- Even realtime strategy

Not used in action games

- Because the internetz

Peer-to-Peer Lockstep Today

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Game design tricks used to hide latency

- Play an animation/sound immediately
- Move units after all clients agreed

Client/Server

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Complete game runs only on the server

- Clients send game commands
- Server sends game state

Server

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Simulates the comlete game

- Everything that‘s relevant for the game state
- Including physics
- Not including cosmetics like particle effects

Does not depend on clients

- Clients can hang
- Clients can drop in and out
- Does not result in problems for other clients

Client

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Really dump client

- Reads input, sends it to the server
- Does not actually run the game
- Just interpolates received game states
- Might run some simulations for effects work
  - Menu animations
  - Particle effects
  - Physics which do not interfere with gameplay
  - …

Pro & Contra

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Very robust

- Clients can hardly cause any problems
- Lags from one client do not propagate to other clients
- No cheating

Very laggy

- Everything lags
  - Even basic movement lags
  - The server simulates every player
- Size of game state has to be rather small

Client/Server today

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Outdated

Client/Server with Client-Side Prediction

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Mix of Client/Server and a little bit of Peer-to-Peer

Server is still the boss

- But clients predict the game state

Prediction

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Prediction

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Just run everything on the client and the server

- But no client-client-communication
- Determinism helps

Most of the time, predictions should be correct

- At least for the player character himself
- Makes controls snappy

For other players pure prediction

- Often incorrect

Failed Predictions

Failed Predictions

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Use the corrected data

- Cause the server is the boss

Hide your mistakes

- Interpolate visuals to avoid jumps
- Or let stuff jump around when out of view

Failed Predictions

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Clients receive only old data

Compare old received data and old predicted data

- When prediction was wrong
  - Recalculate new current state based on received old state
    - Then interpolate

Failed Predictions

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Can cause unfair situations

- Visuals show that an enemy was hit but he really wasn‘t

No real solution possible

- Virtual life is not fair :-(

Network Protocols

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All IP based

Everything just works like the internet

IP

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Internet Protocol

Packet based

- No direct connections
- Much like post packages
- Unreliable

TCP/IP

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Direct connections

Reliable streams of data

Super easy

TCP/IP

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Builds on a package based protocol

Makes sure every package arrives

Makes sure all packages stay in the same order

TCP/IP

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Reorders packages

Requests missing packages again

One missing package can cause huge delays

Missed packages

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Unacceptable for most applications

Mostly not important for games

- Positions from 30ms ago are outdated anyway
  - Gets new positions all the time anyway

UDP

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Basically IP plus port numbers

Works with packages directly

UDP

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Use packages directly for game state

Implement TCP like functionality for other stuff

- Highscore lists,…

UDP

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Has additional difficulties

- Applications have to measure transfer rates
- Typical packet sizes (< 512 Bytes) are hopefully enough for one piece of game state

The Future

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More Predictions…

Game-Streaming

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Run game on the server

Client sends input events

Server sends video stream

Game-Streaming Pro & Contra

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Game works like a split-screen game on the server

- Super easy development

Video compression can look ugly

- But internet connections get faster all the time

Latency is as bad or worse than basic Client/Server

Latency

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Speed of light is ~300000 km/s

Circumference of the earth ~40000 km

At least one data roundtrip necessary

- > 0.1 seconds for far away servers
  - Too slow

Latency

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Streaming Game providers try to place lots of server at different places

- To minimize distance and therefore latency

Typically ends up at speeds that are ok for some persons

- And some genres

Not acceptable for VR

- Super low latency is critical for good VR

Shinra

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Research project by Square-Enix

Wants to use streaming to create new types of multiplayer games

Current multiplayer games are restricted by the amount of data that can be transfered

- Doesn't matter when just streaming audio/video data

Plus want to just use more hardware per game

- For more physics or whatever

Alternative strategies?

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Maybe cleverly send compressed game state of close surroundings to individual clients

Debugging and Profiling GPU programs

2.1 Hardware

What makes it so important that texture compression algorithms are directly supported by the hardware?

Reading pixels is the most fundamental and speed critical operation of GPUs.

2.2 Artifacts

ETC is a lossy texture compression algorithm. Describe what characteristics an image should have to make those losses clearly visible.

Big contrasts across block borders.

2.3 Tilemaps

Outline an algorithm to display tilemaps correctly in a 3D environment.

MegaTextures for example.