Sirikata

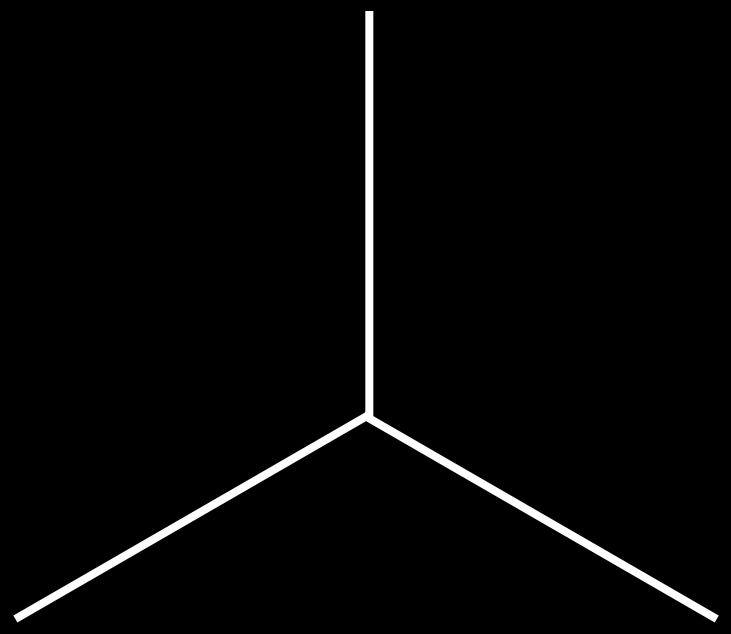
ISTC-VC Virtual Worlds Workshop
August 18, 2011

What Is It?

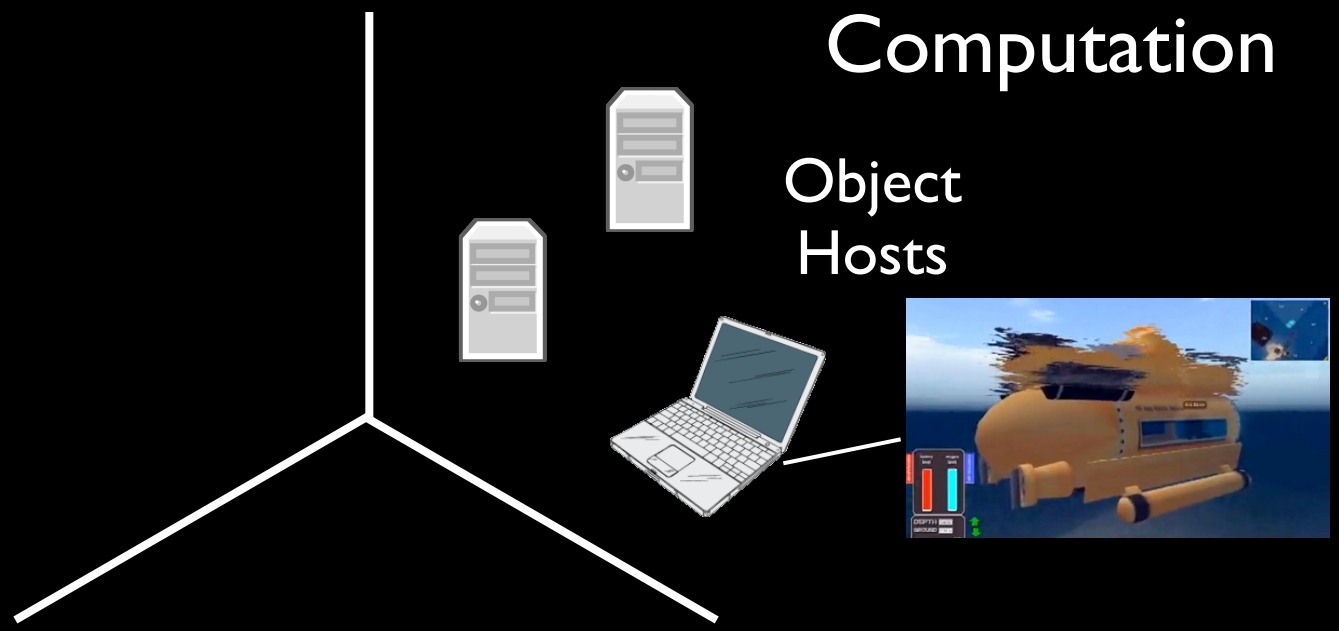
- Software platform for 3D virtual worlds
- Princeton/Stanford collaboration

- Goal: A user should be able to interact with the whole virtual world.
- Goal: Easy application development.

Sirikata Architecture



Sirikata Architecture



Sirikata Architecture

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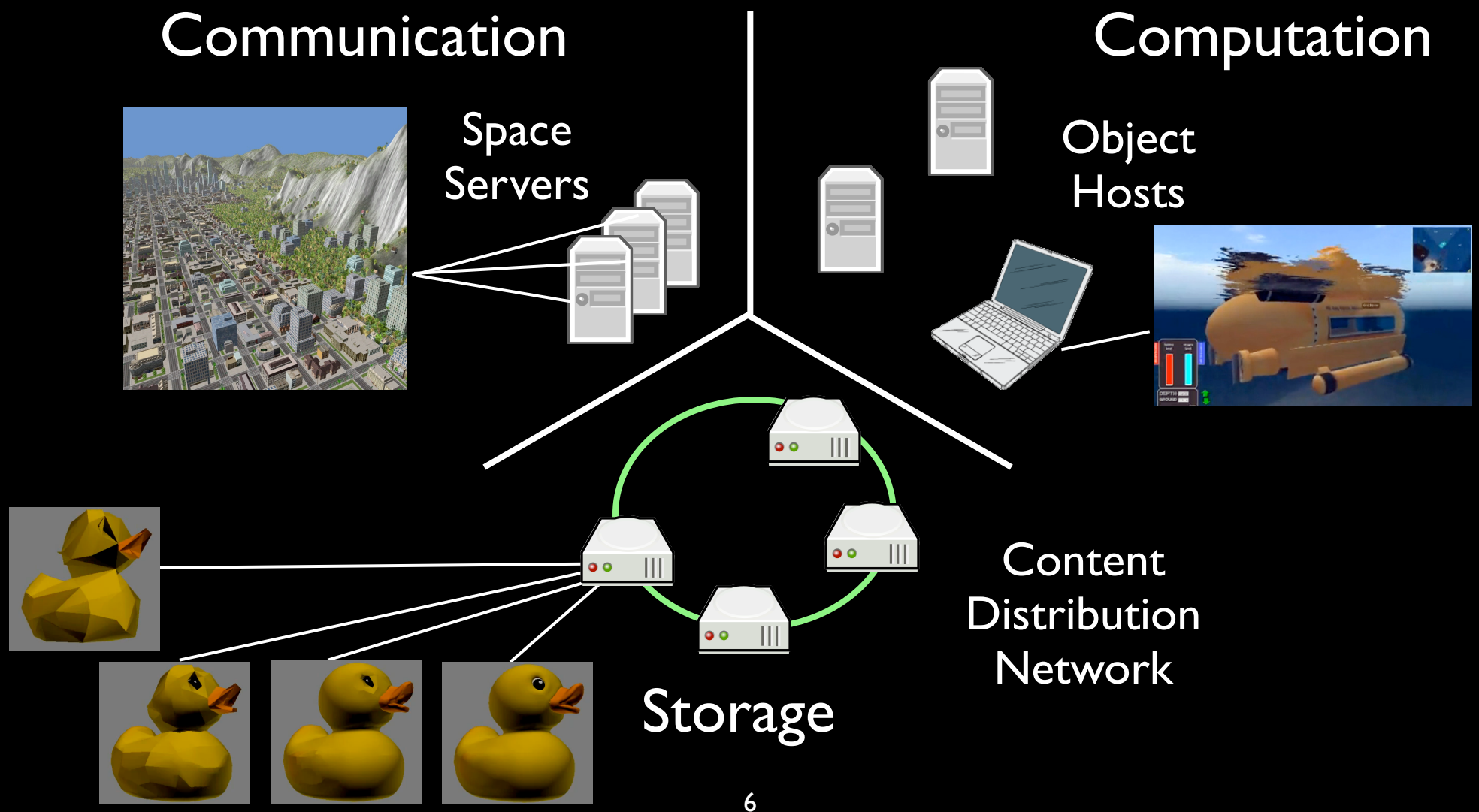

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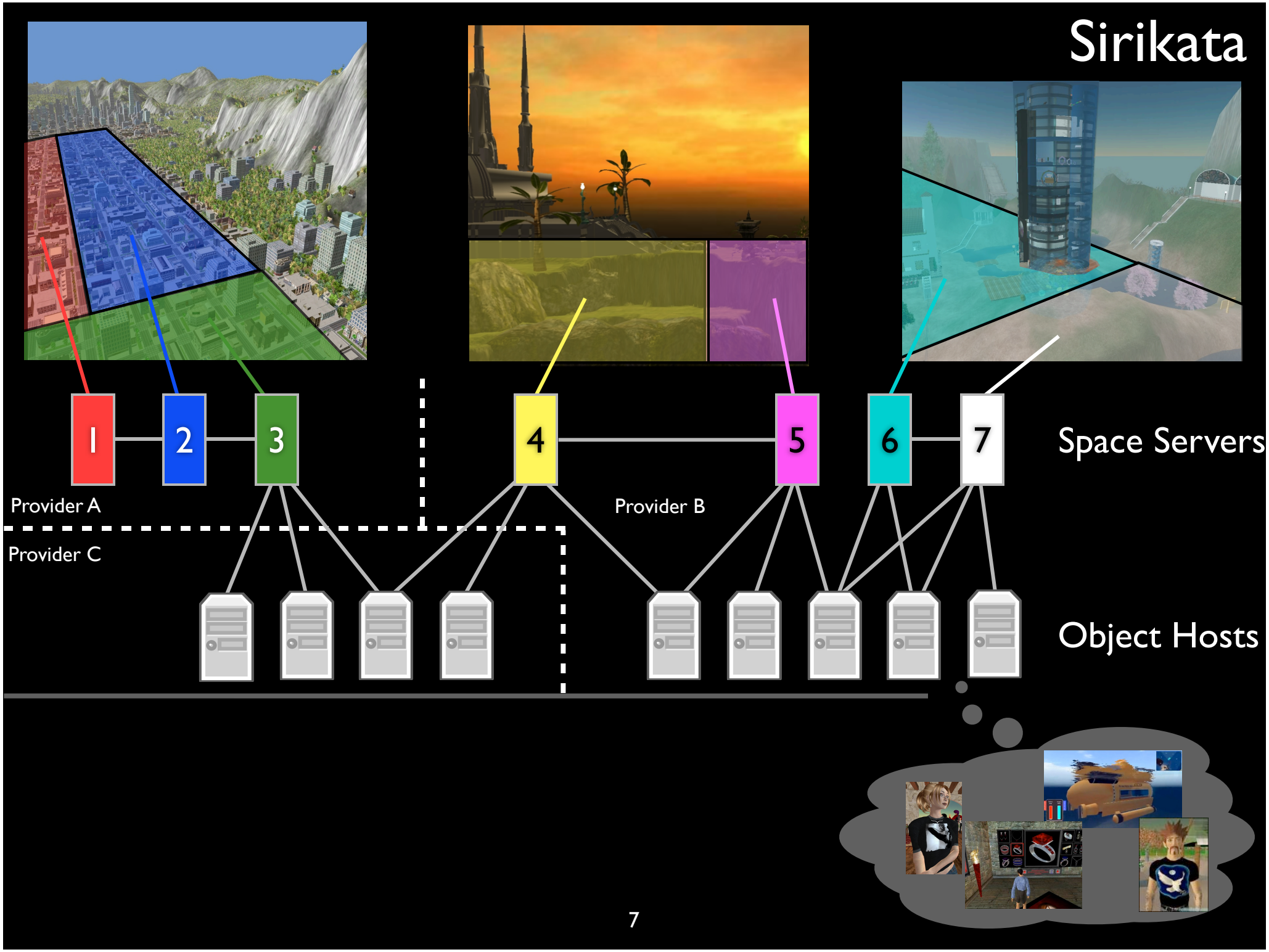
1
2
3
4
5
6
7
Space Servers
Provider A
Provider B
Provider C
Object Hosts

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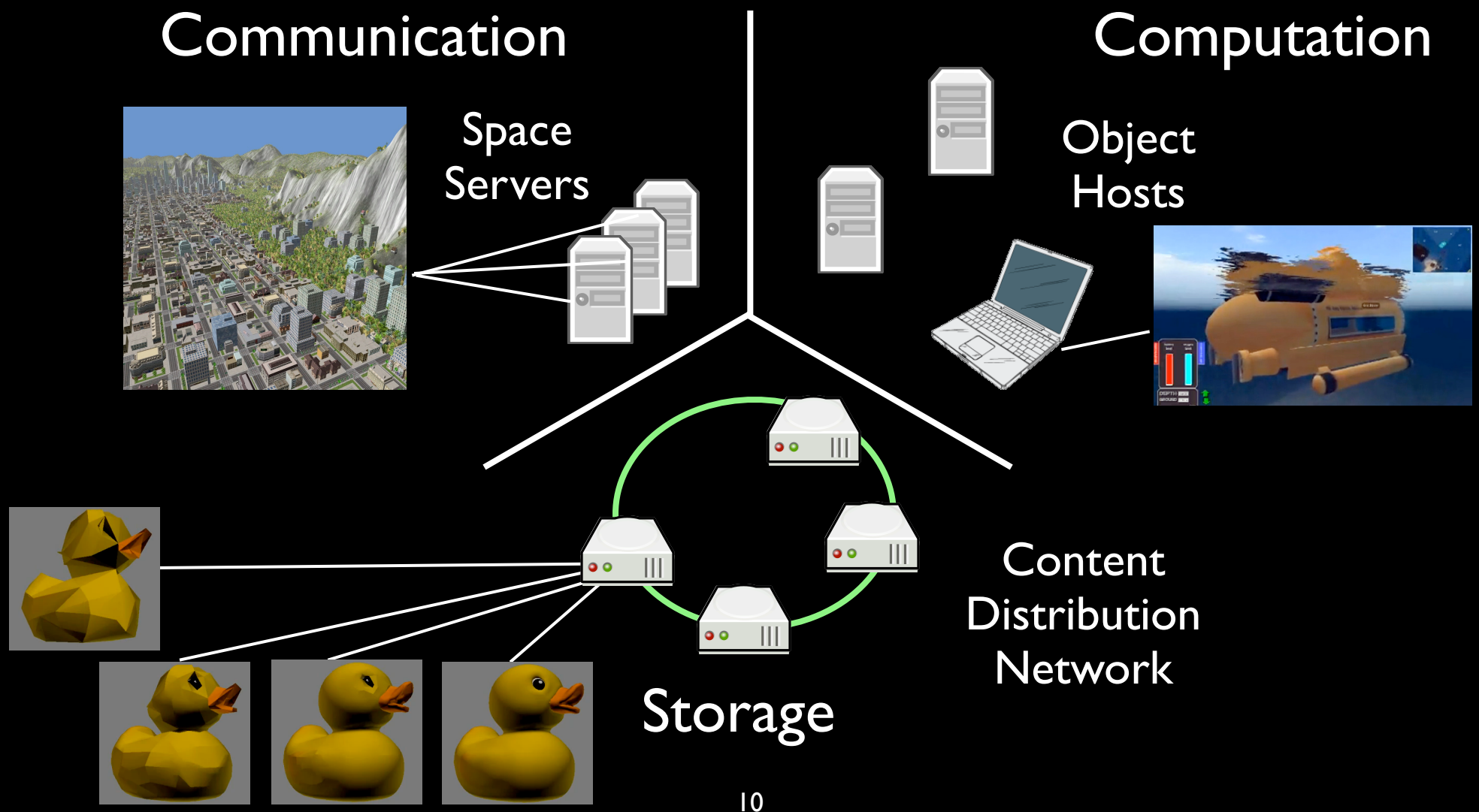
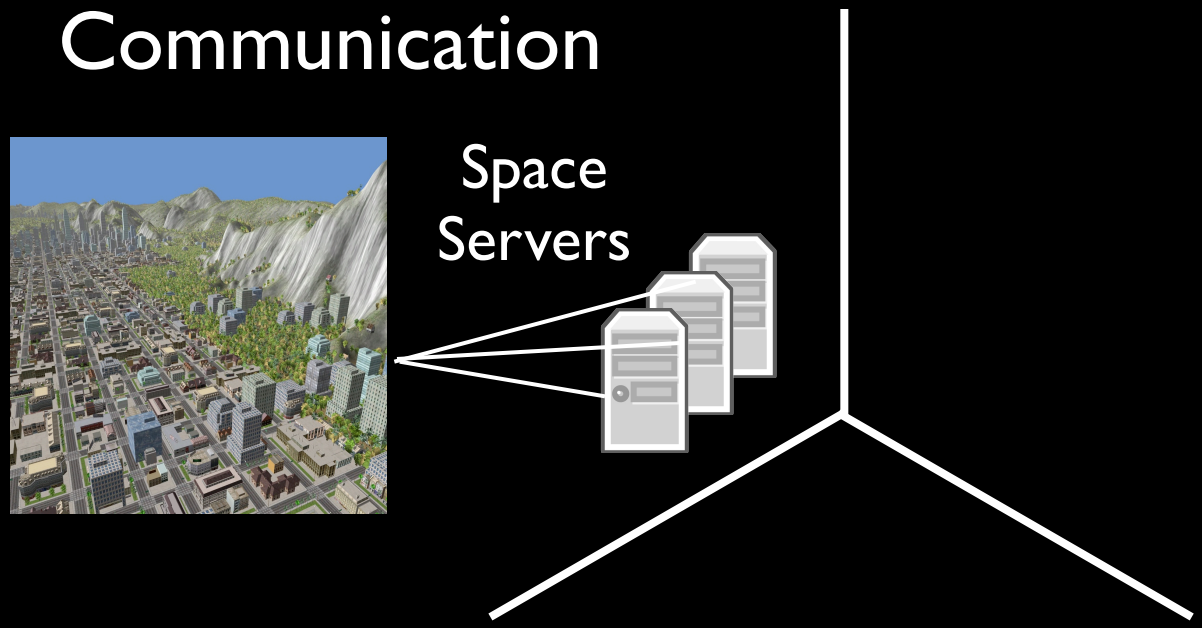
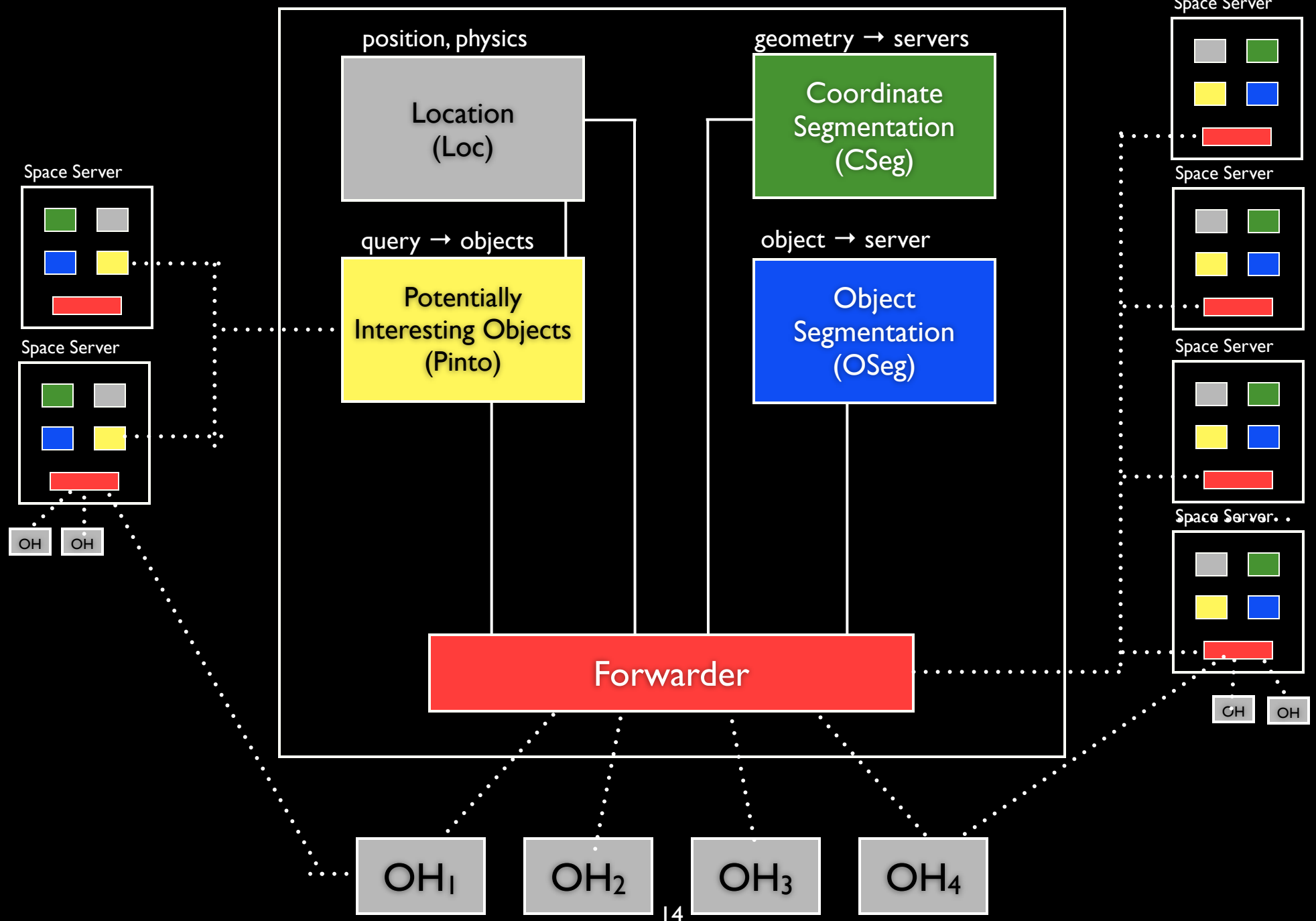


Sirikata Architecture

Communication



Space Server



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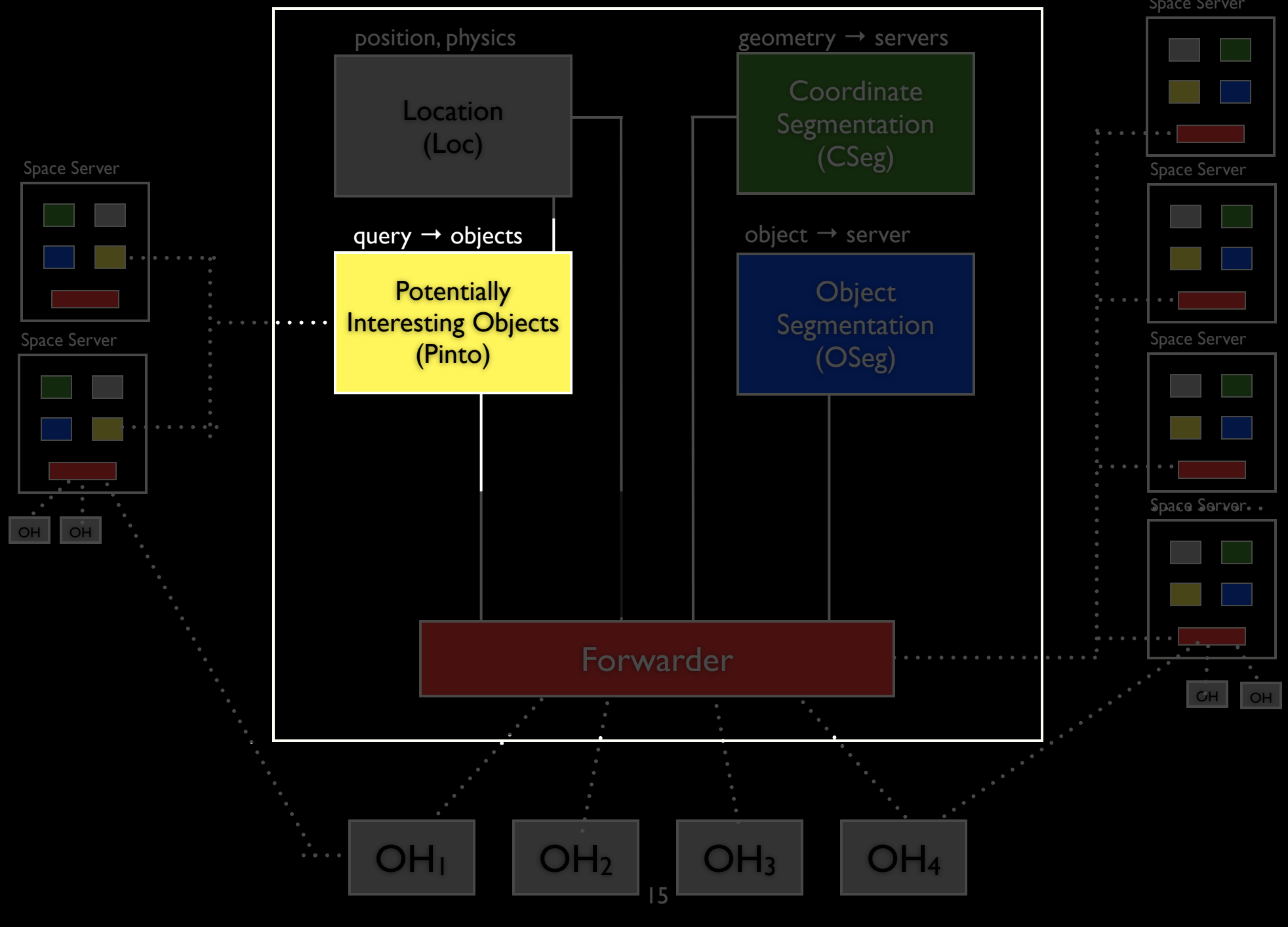
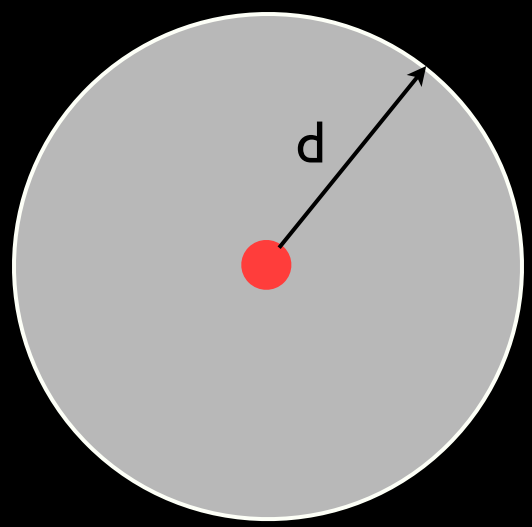
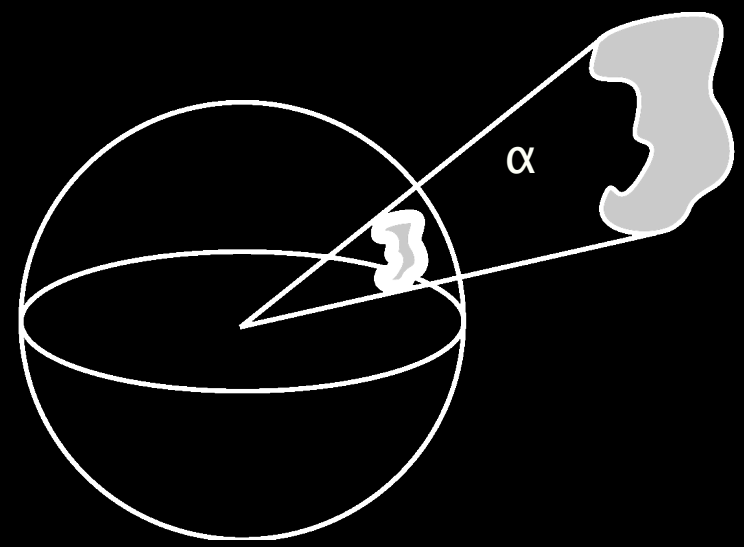


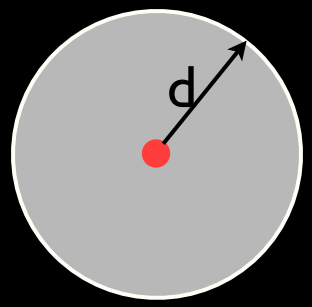
Solid Angles



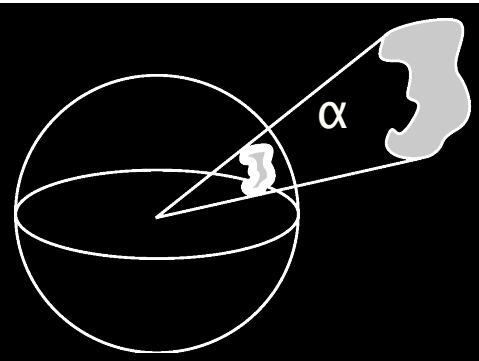
distance



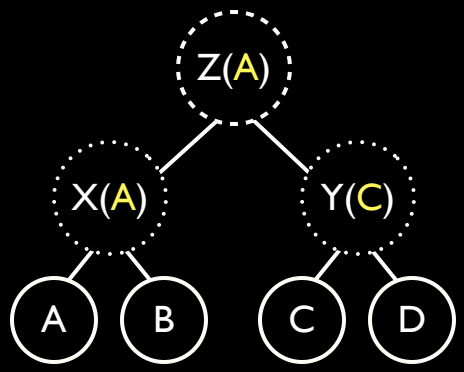
solid angle



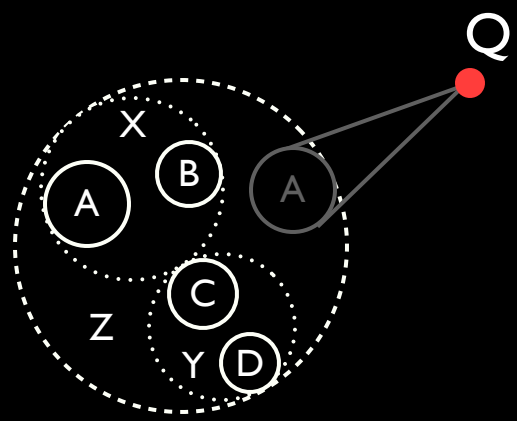
distance



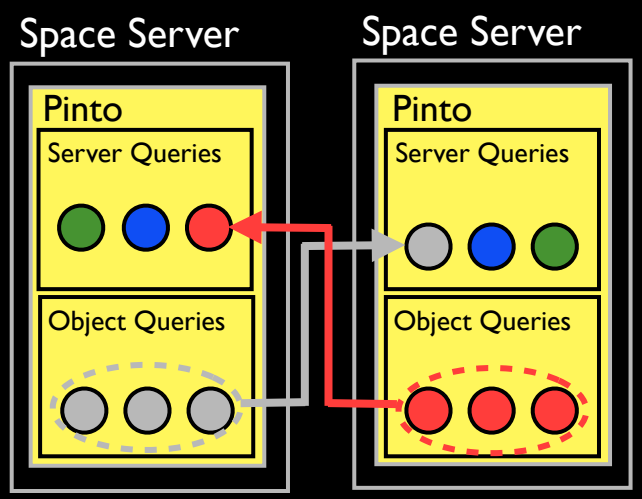
solid angle

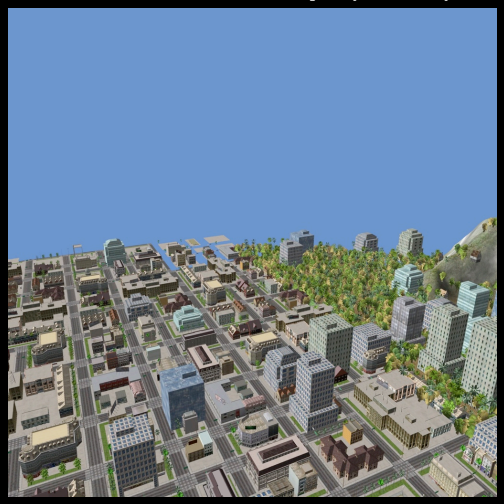


bounding volume hierarchy (BVH)

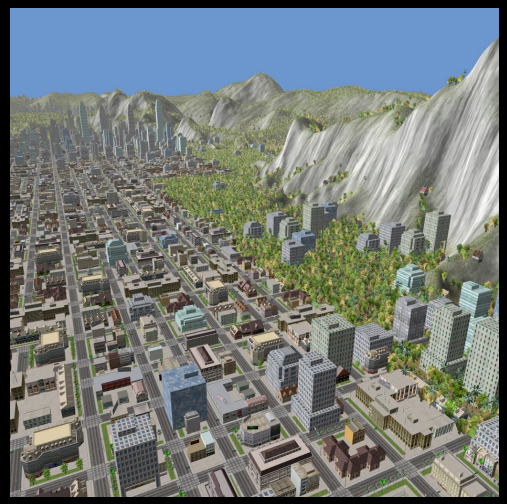


BVH geometry

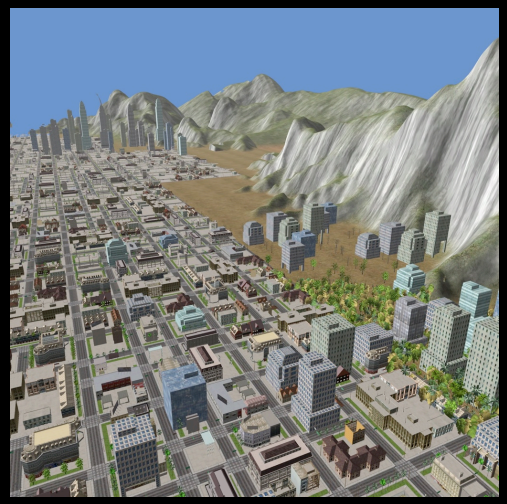




distance (20,000)



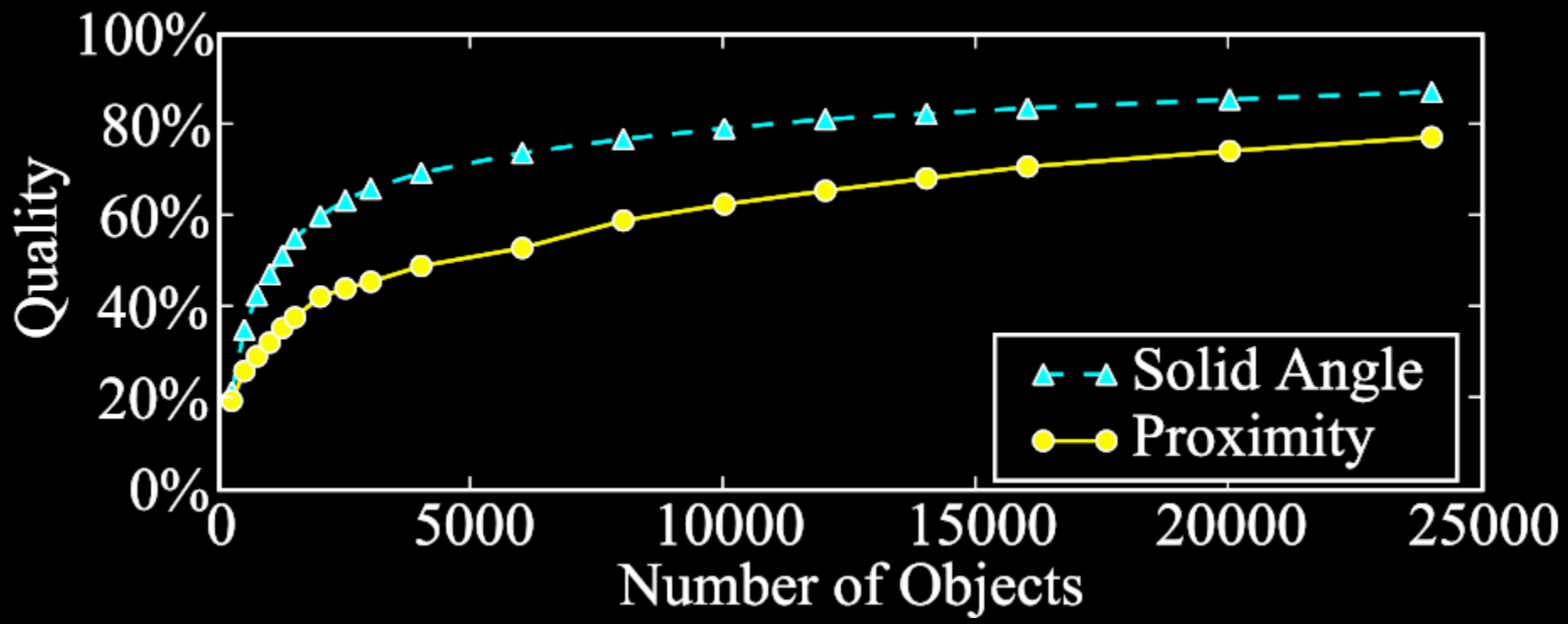
ideal (10,000,000)[17]



angle (20,000)

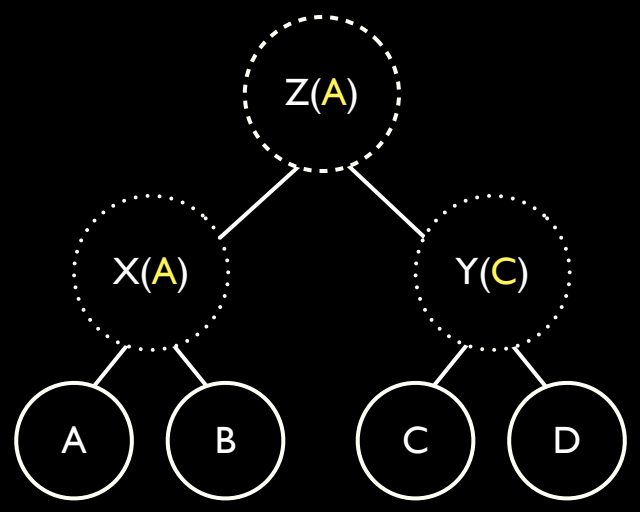
Pinto

Query Comparison

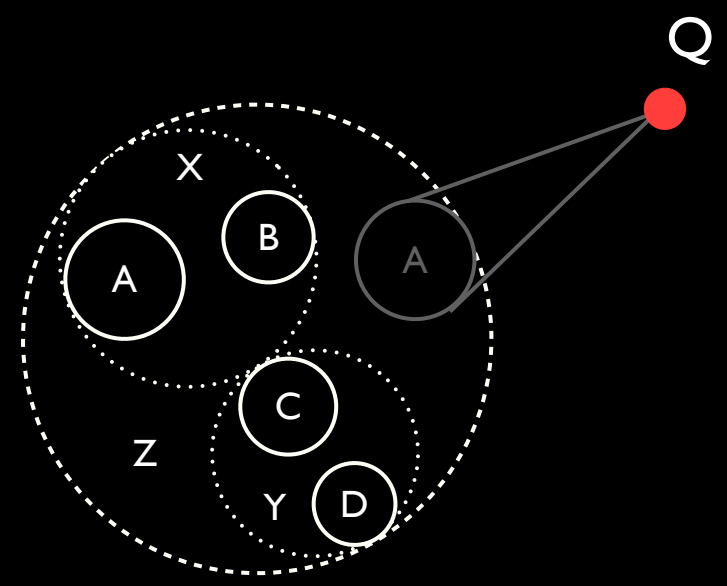


- For same # of objects, better quality
- For same quality, fewer objects

LBVH: Largest Bounding Volume Hierarchy

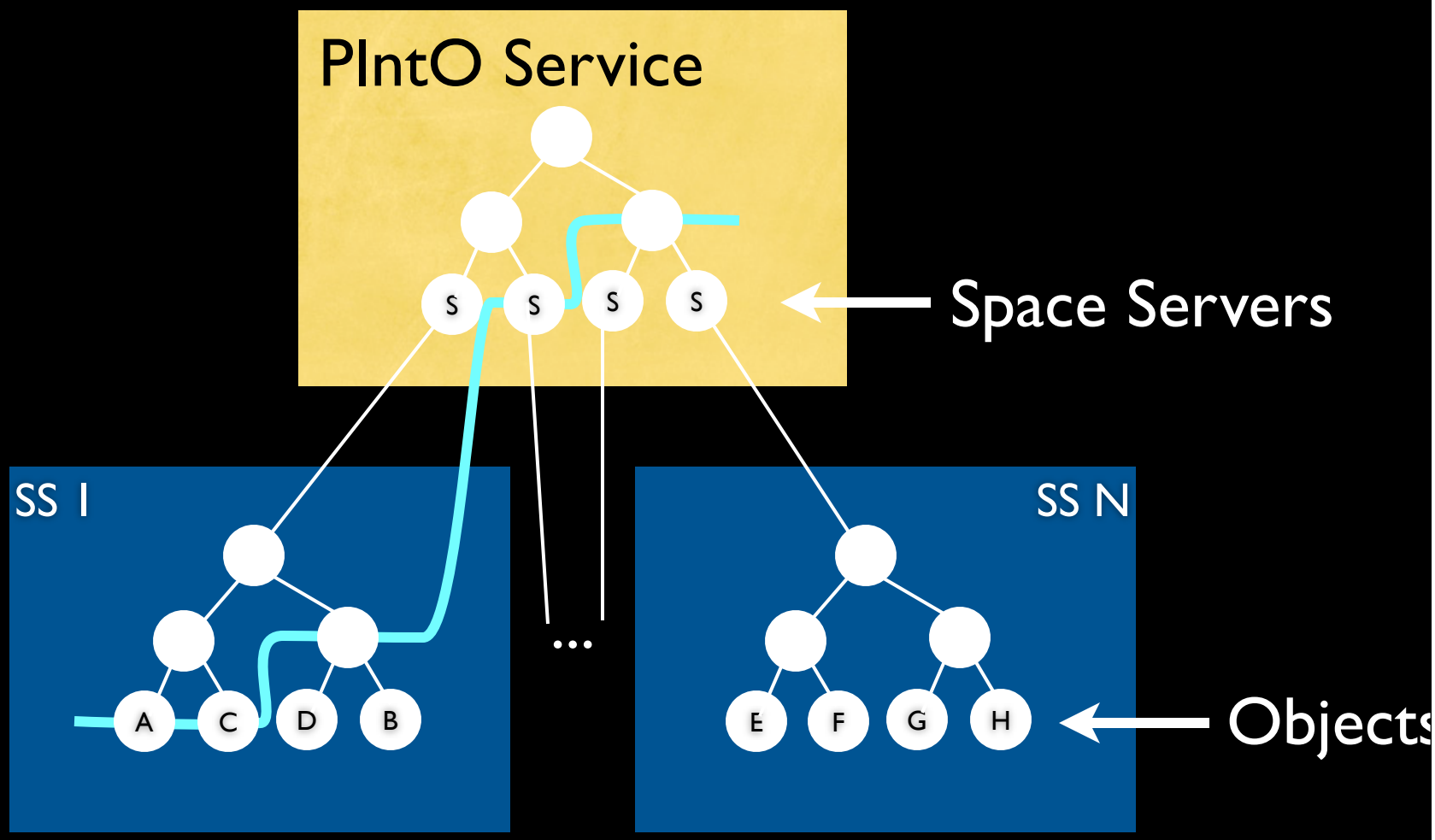


bounding volume hierarchy (BVH)



BVH geometry

PIntO Conceptual Model



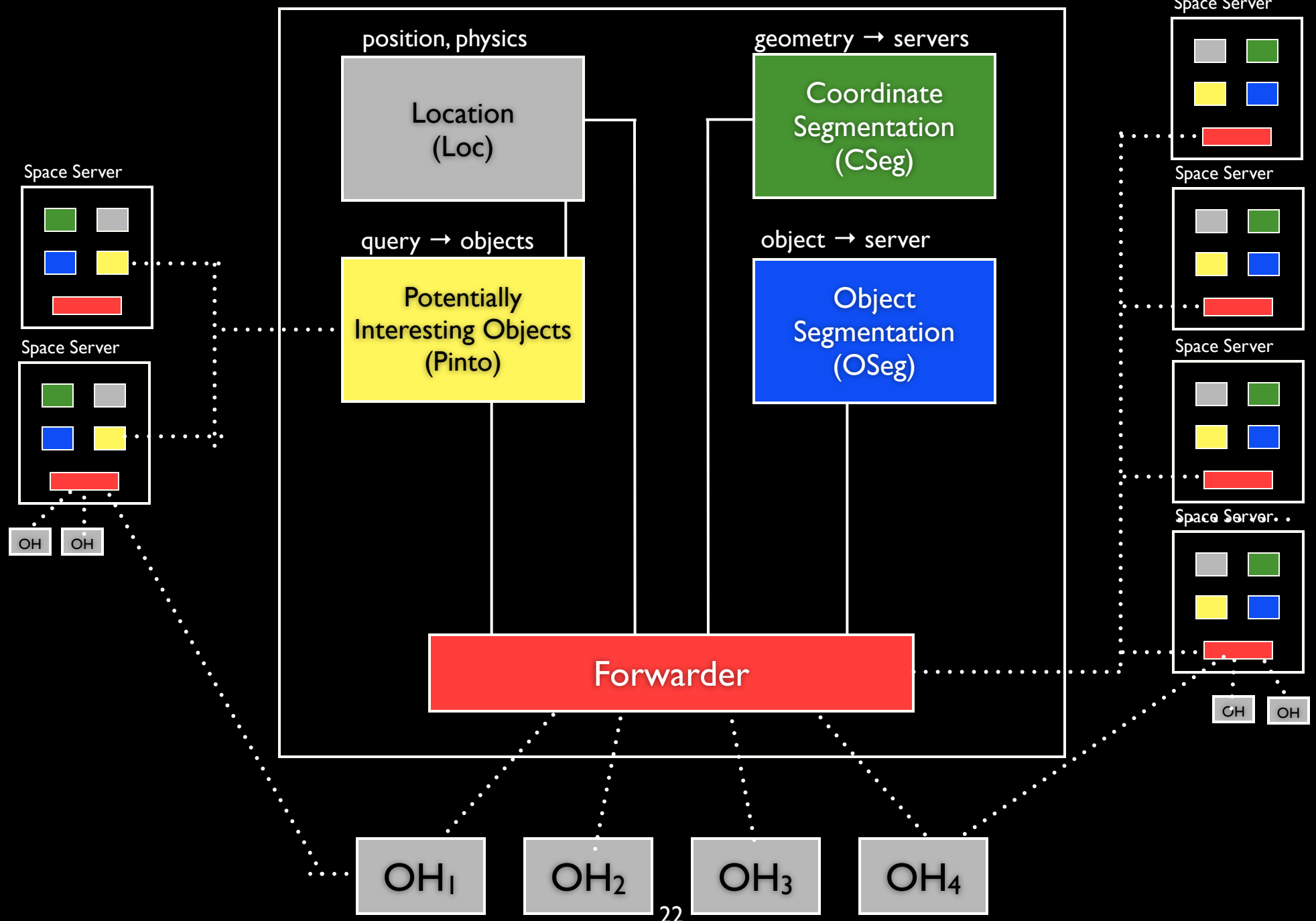
Distance

Ideal

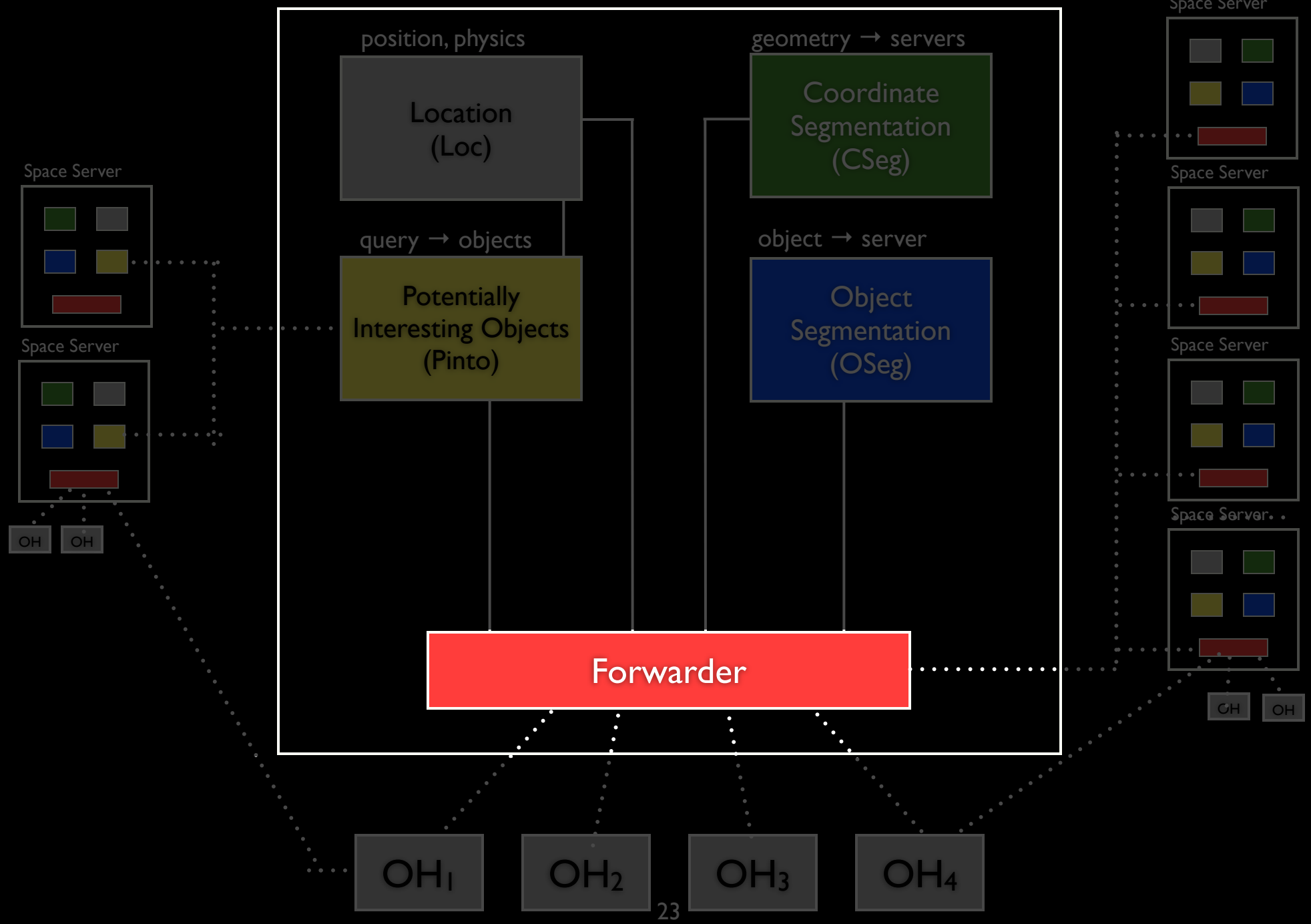
Cuts

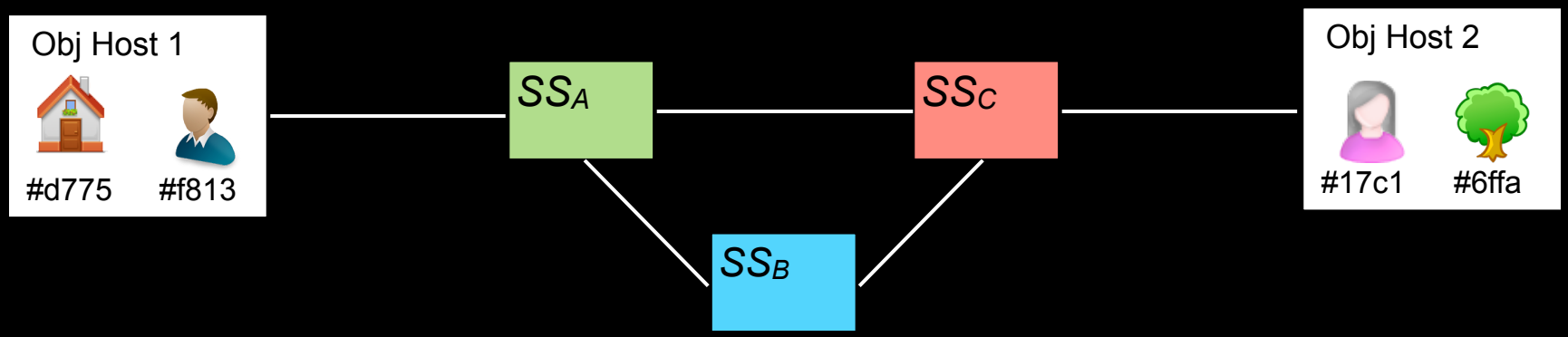
Aggregates

Space Server



Space Server

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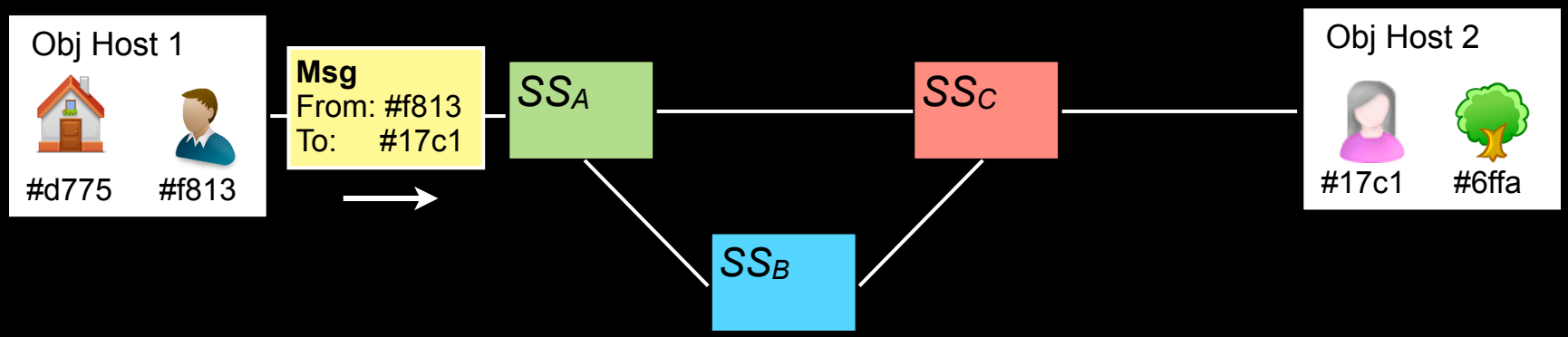
#d775
#f813
SS_A
SS_C
SS_B
Obj Host 2
#17c1
#6ffa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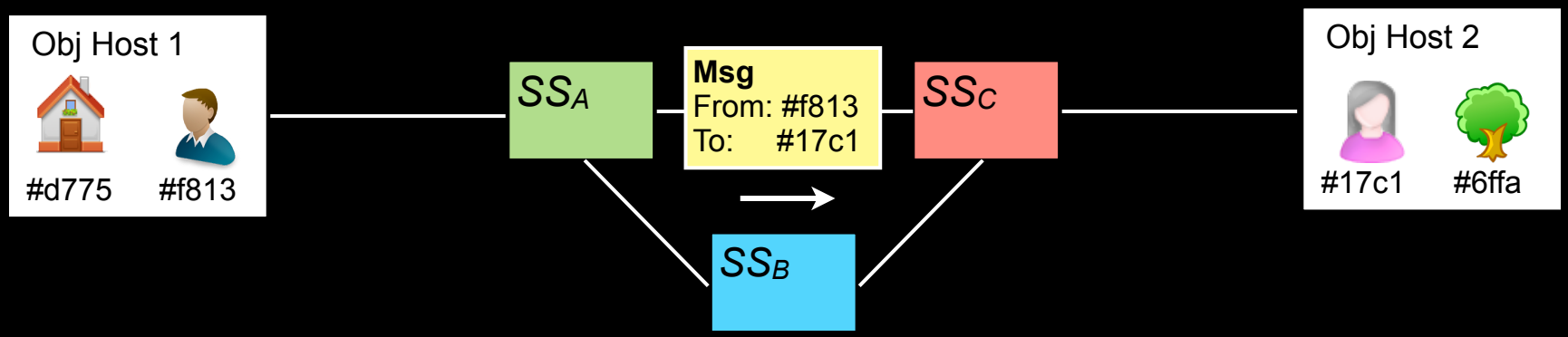
#d775
#f813
Msg
From: #f813
To: #17c1
SSA
SSC
SSB
Obj Host 2
#17c1
#6ffa


Obj Host 1
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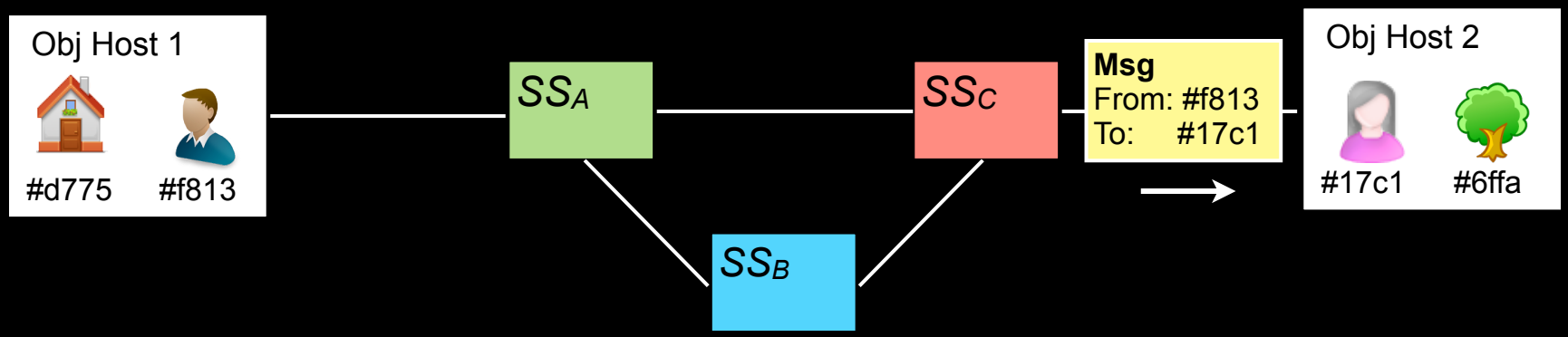
Obj Host 1
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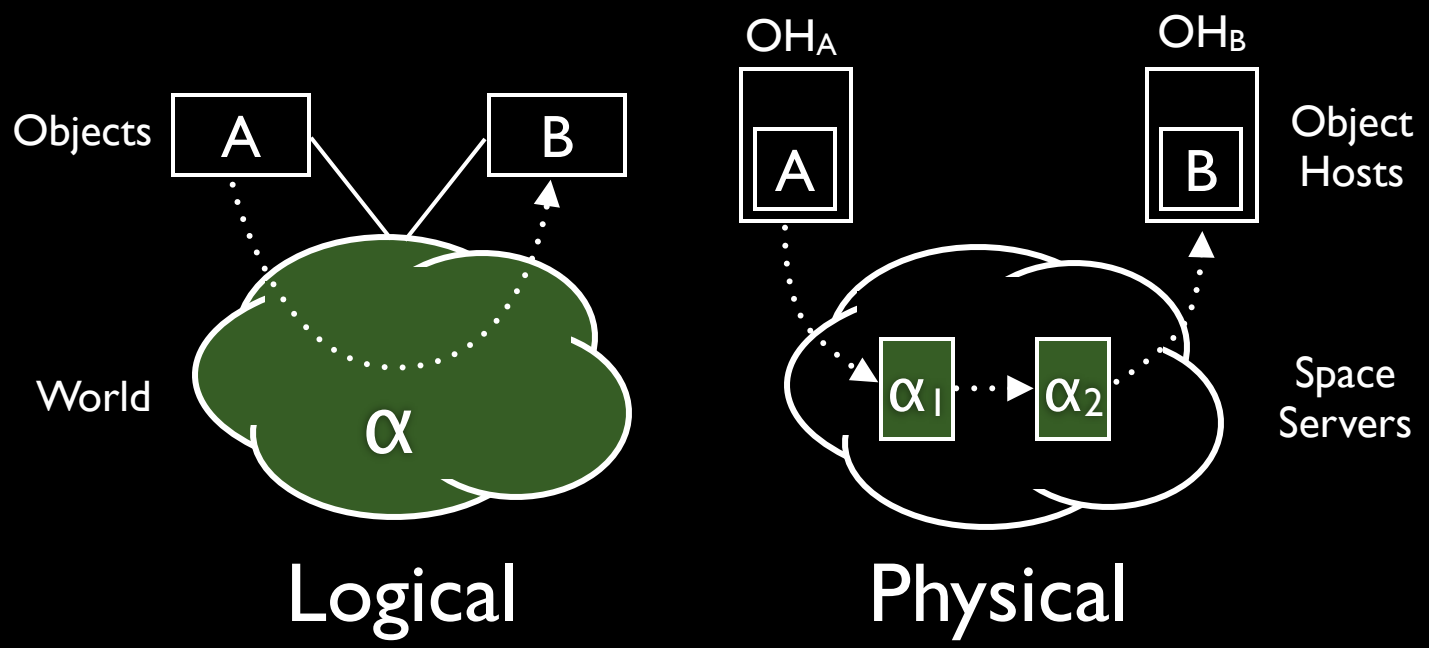
#f813
SS_A
SS_C
SS_B
Msg
From: #f813
To: #17c1
Obj Host 2
#17c1
#6ffa

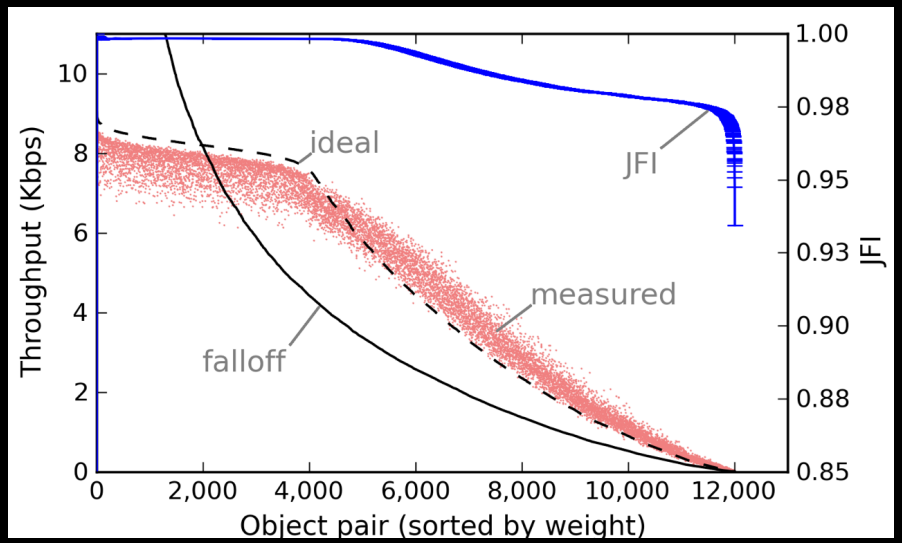
Forwarder



$$w_i = F(R_s, R_d) = \int \int f(p_s, p_d)\, d_d\, d_s$$

$$r = d(p_s, p_d)$$

$$f(r) = \frac{1}{(sr + \rho)^2 \cdot \log^2(sr + \rho)}$$



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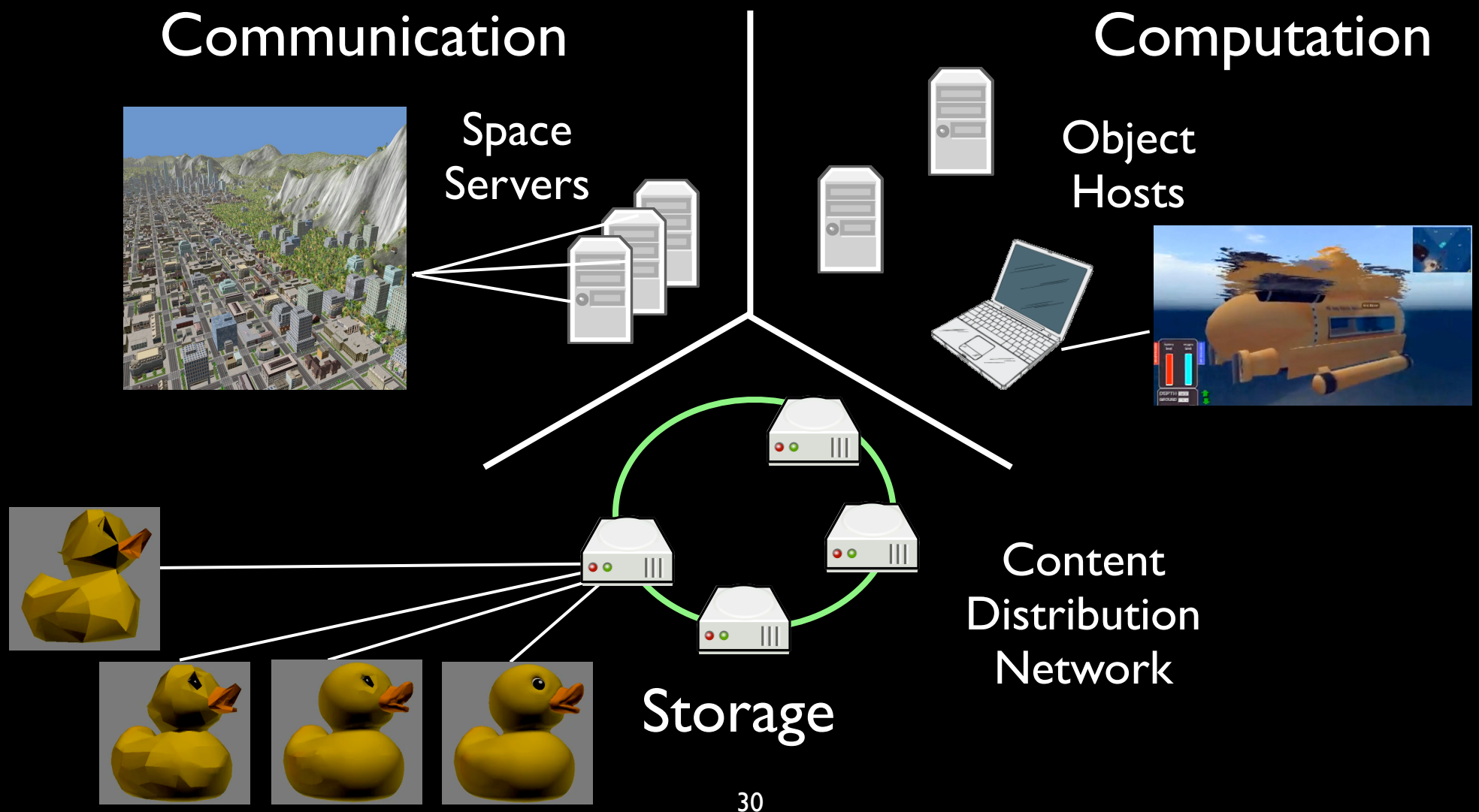

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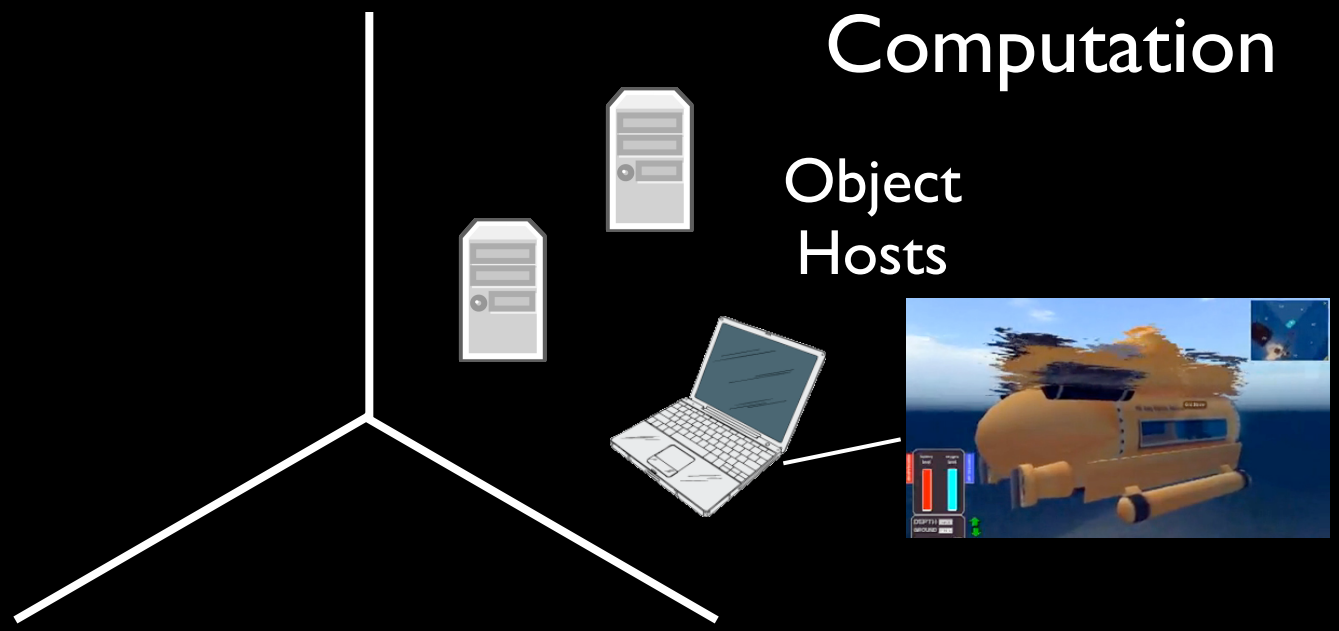
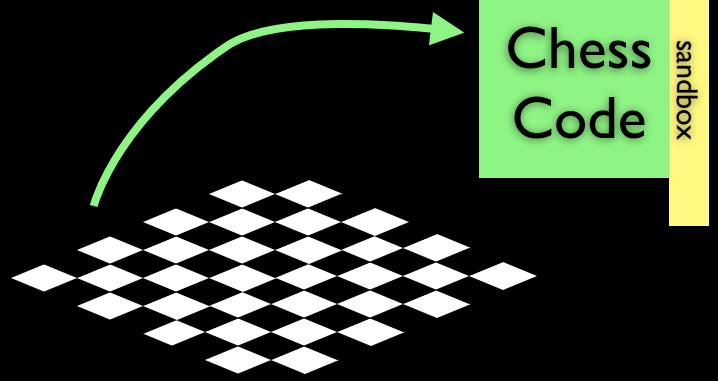
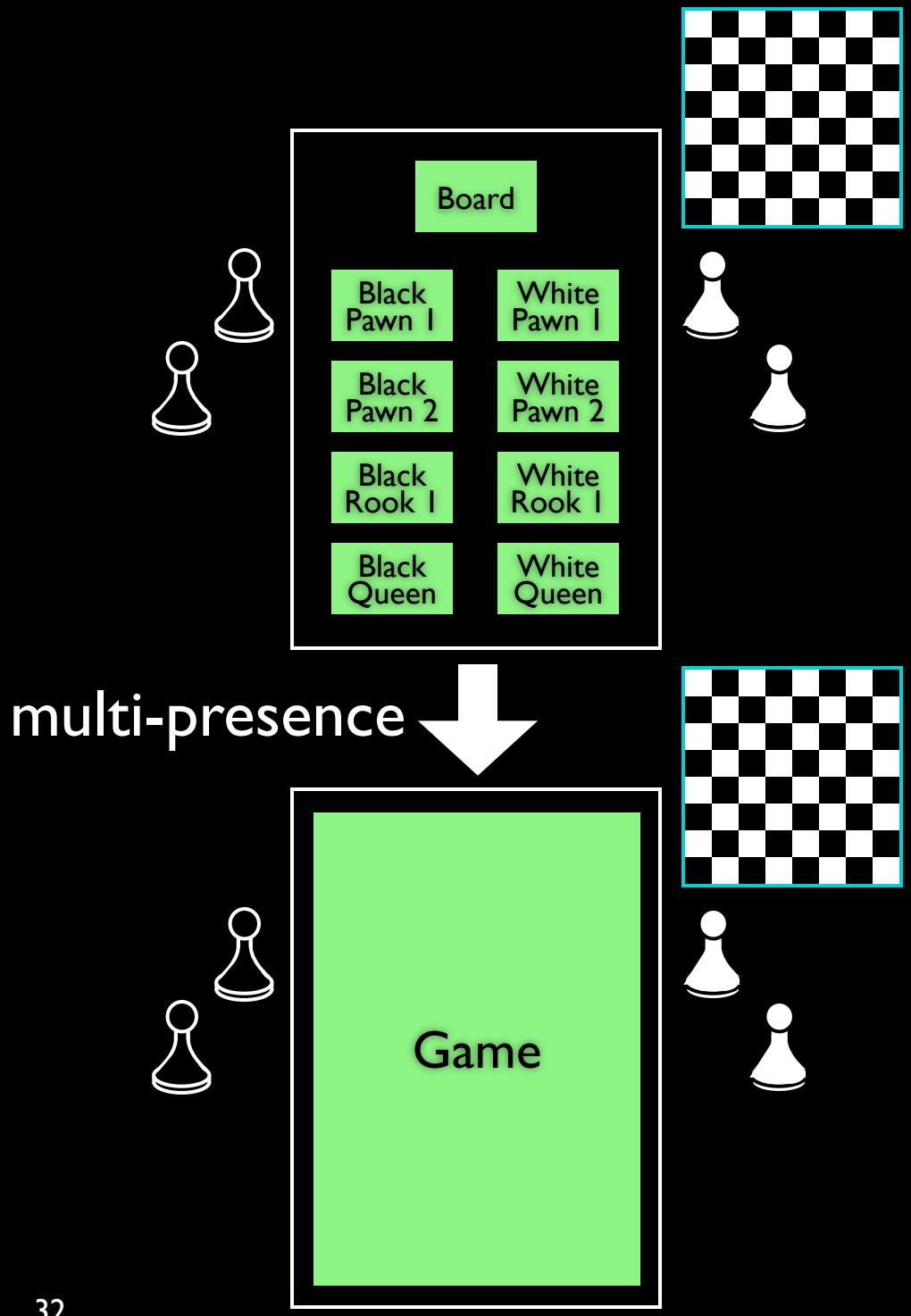


Emerson,

a language for virtual worlds

sandboxing





Survival Game: Zombie

Only one zombie attacks at a time

Zombie Game: Basic Actor Model

Zombie 1 script

Zombie 2 script

Zombie 3 script

Zombie Game: Basic Actor Model

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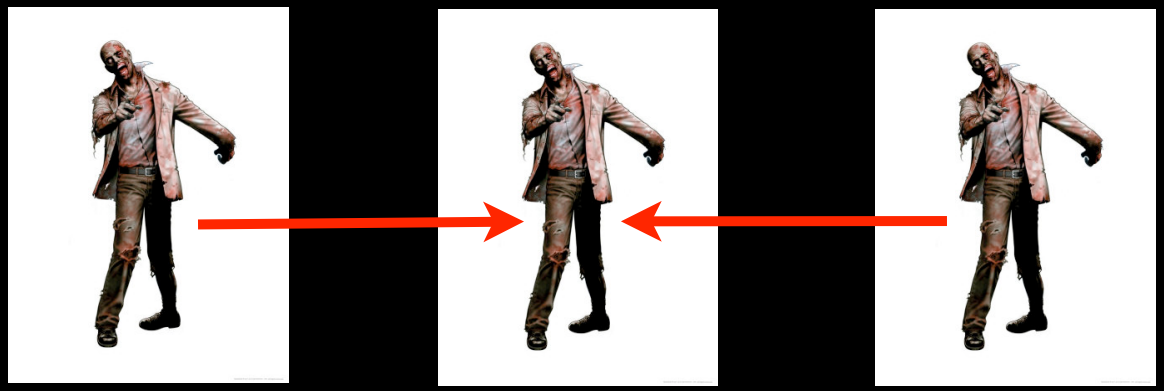
Zombie 2 script

Zombie 3 script

Zombie Game: Basic Actor Model



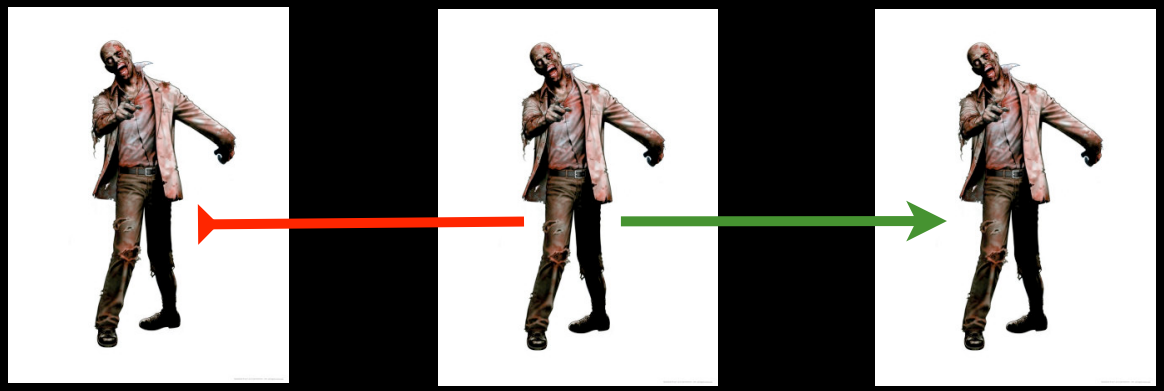
Lock Request

Zombie 1 script

Zombie 2 script

Zombie 3 script

Zombie Game: Basic Actor Model



Lock Granted

Zombie 1 script

Zombie 2 script

Zombie 3 script

Zombie Game: Basic Actor Model

Zombie Attack!

Zombie 1 script

Zombie 2 script

Zombie 3 script

Zombie Game: Multi-Presence

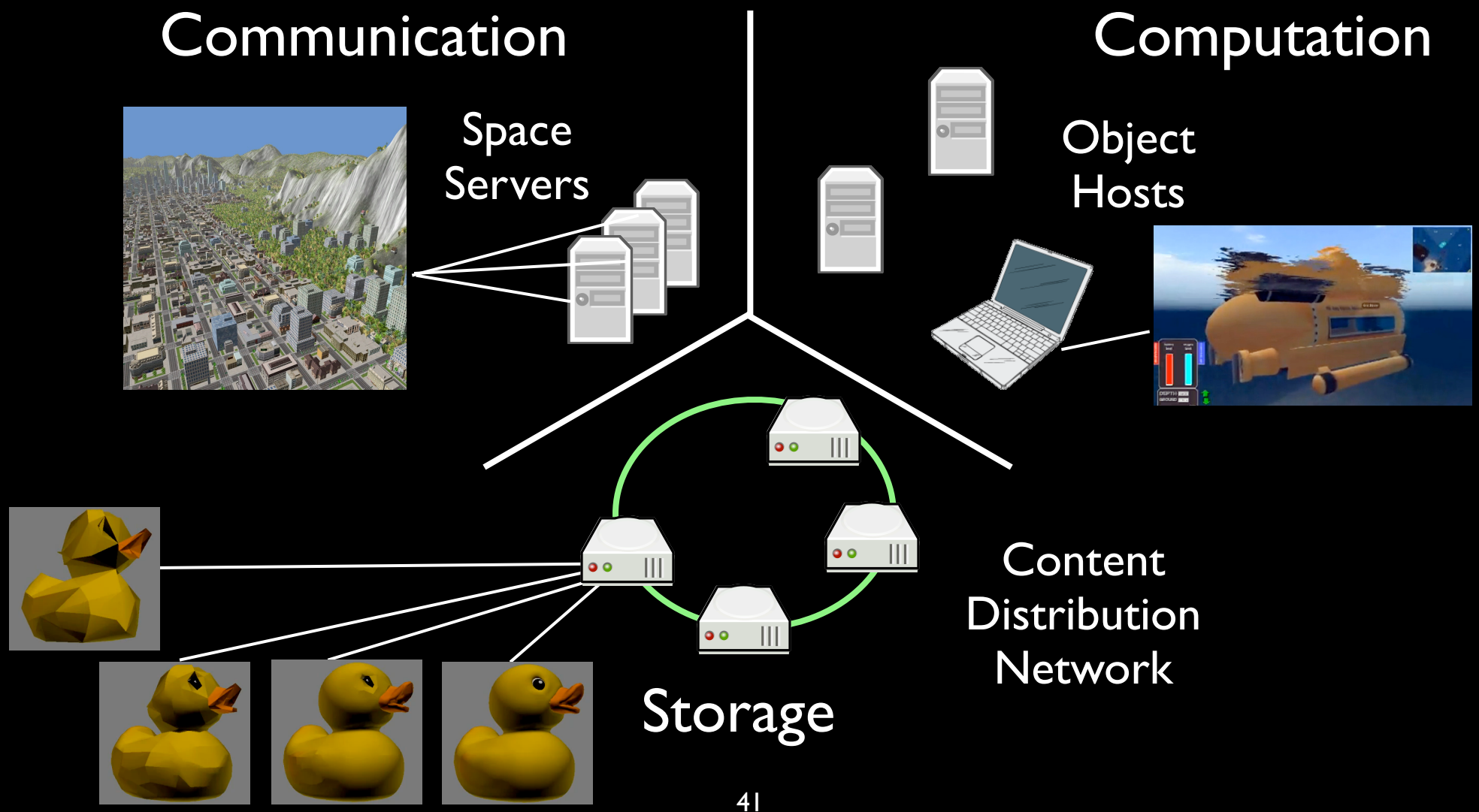
Zombies Script

Zombie Game: Multi-Presence

Zombies Script

Zombie A attack!

Sirikata Architecture



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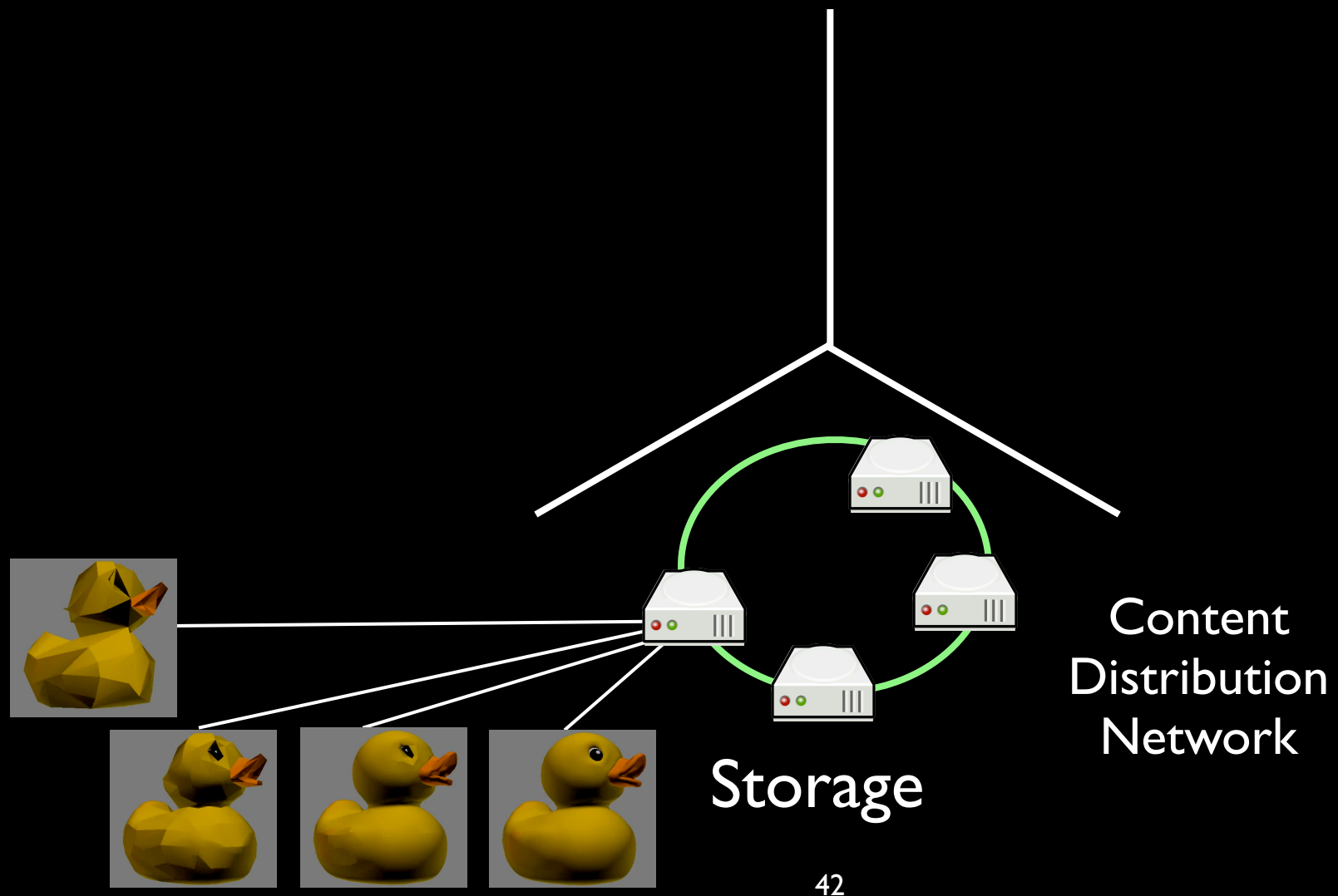
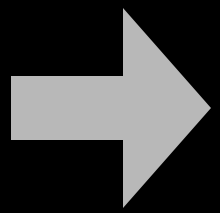


Sirikata CDN

- http://open3dhub.com
  - meerkat:///jterrace/Seagull.dae/optimized/Seagull.dae
- Authentication through OAuth
- Wide-area replication through Cassandra
- DONAR for mapping to nearest replica
- Caching to reduce latency

Making It Easy

Model upload



Sirikata CDN

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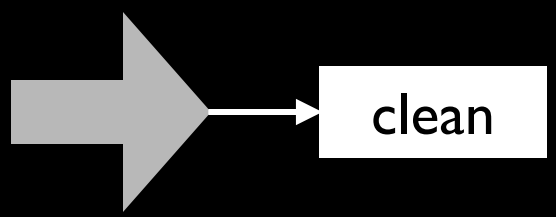

Sirikata CDN

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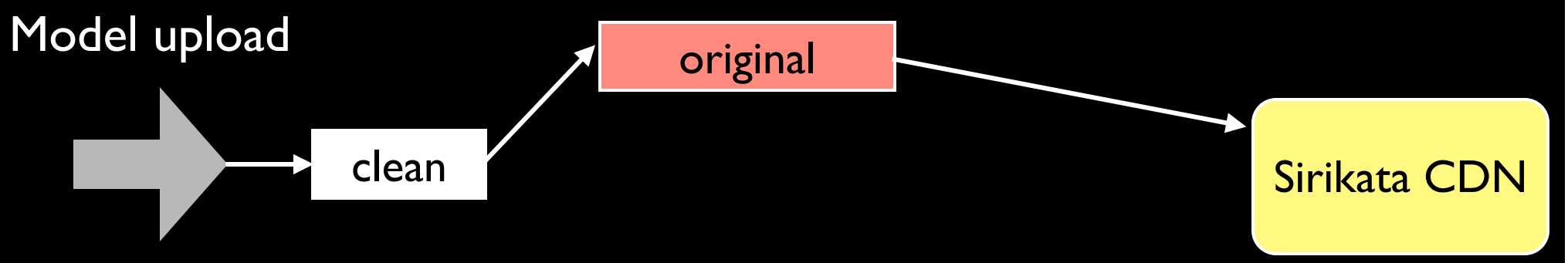

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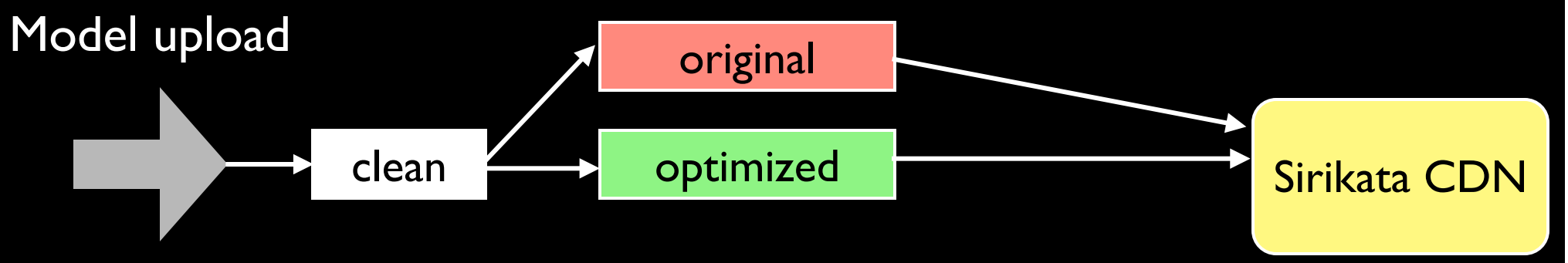

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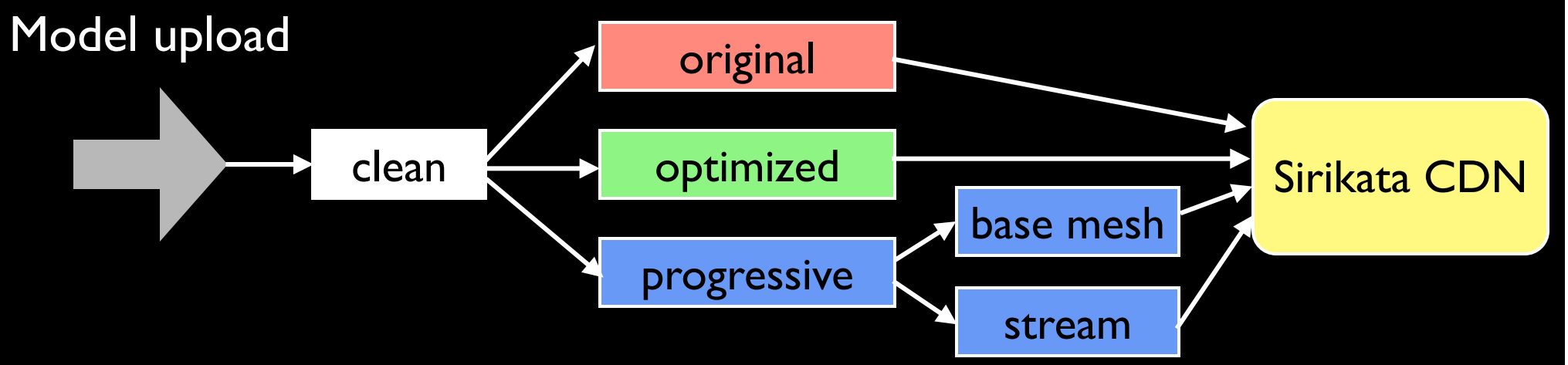

Content Pipeline

- Check COLLADA model is valid
- Asynchronously upload optimized model
  - Reduces materials, atlases textures, generates triangles
  - Average draw calls reduced from 13 to 5
- Asynchronously upload progressive model
  - Base mesh at low detail
  - Download progressive stream to increase detail
  - Allows fine-grained client control of system resources

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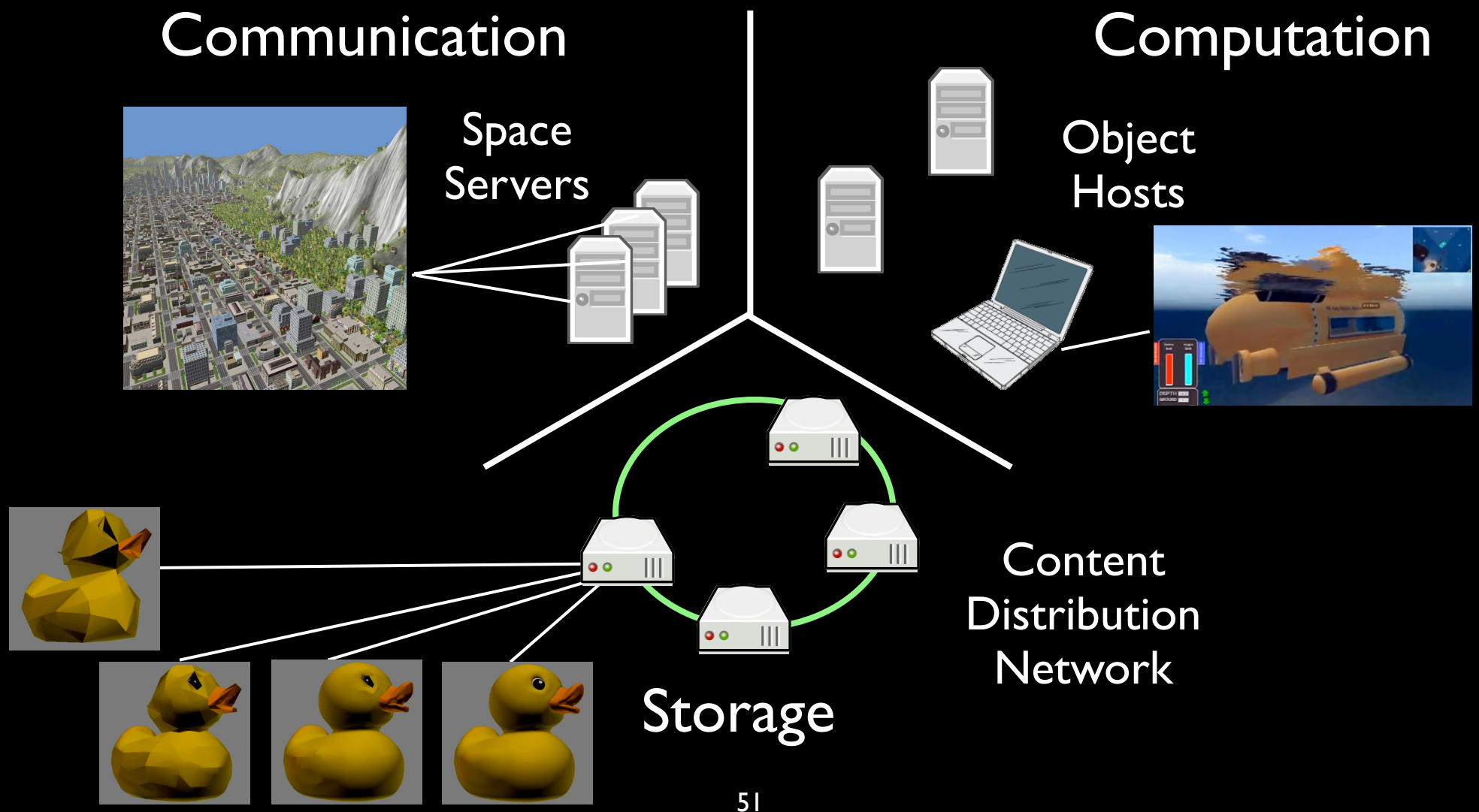
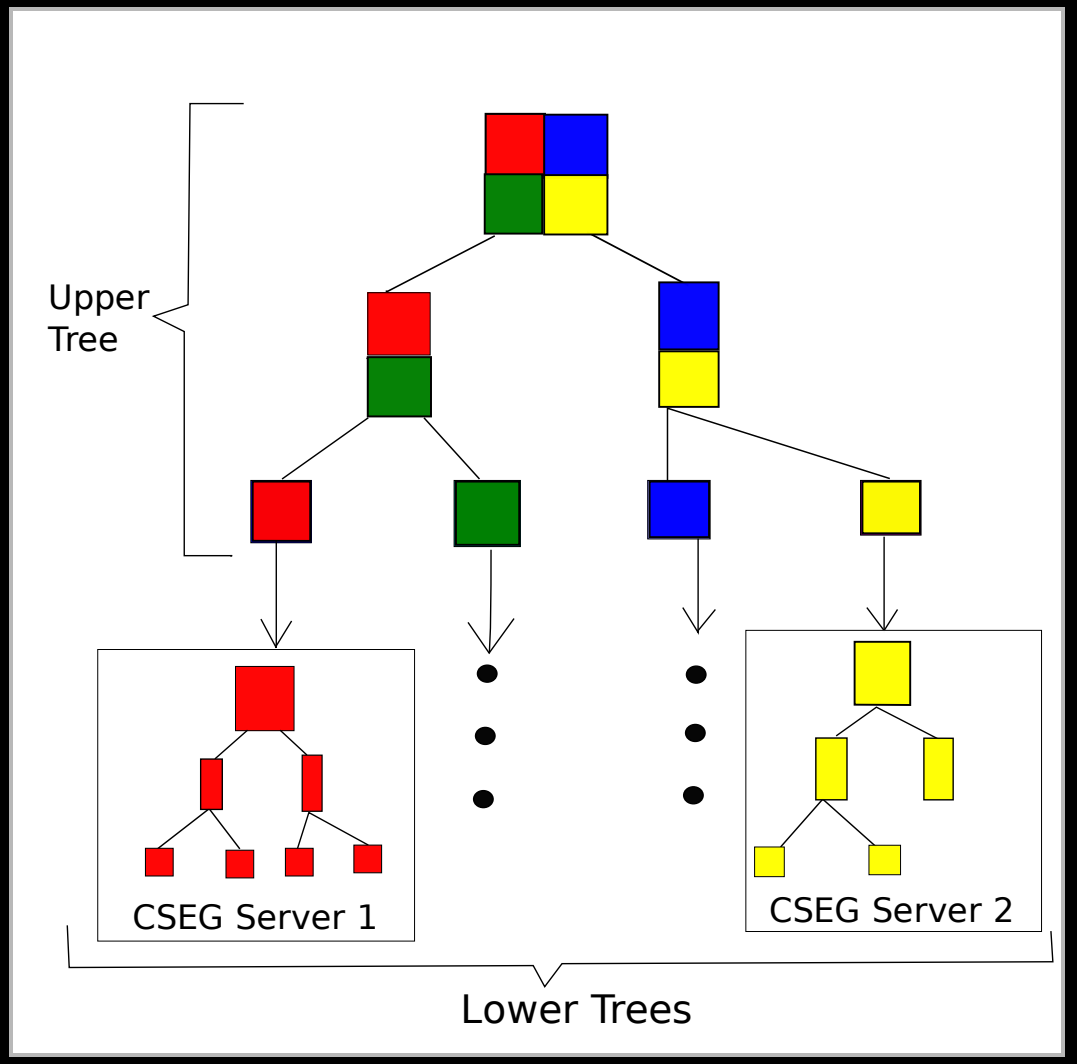


Questions

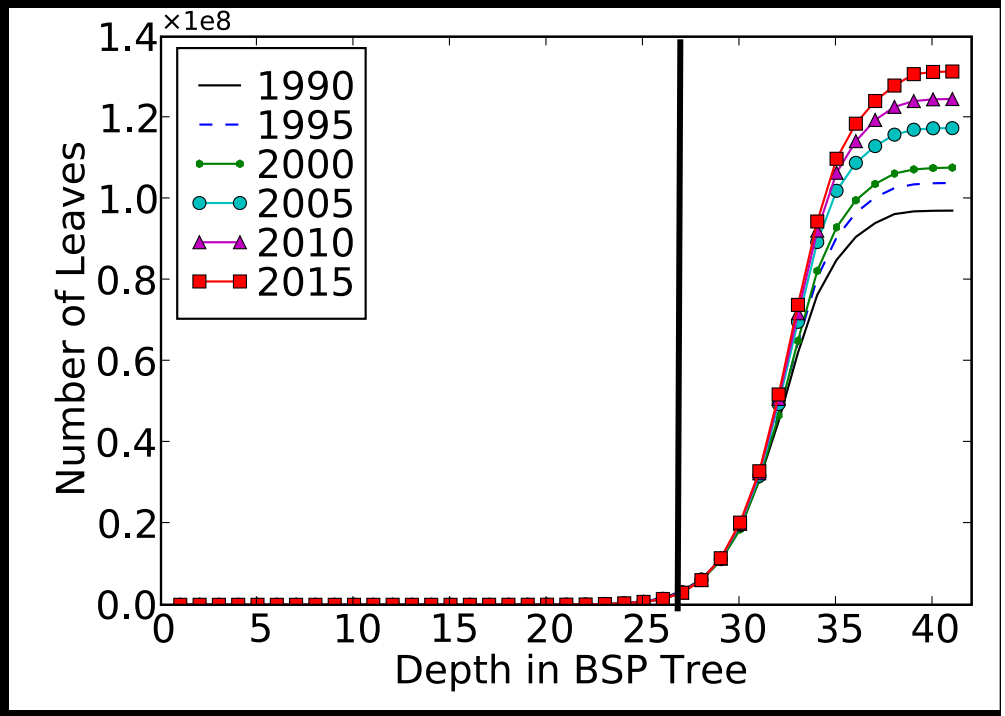
Coordinate Segmentation

- Distributed kd-tree
  - Hierarchically divides space into regions
- Tree "cut" into two levels
  - Replicated, highly stable upper tree
  - Much more dynamic lower trees managed by CSEG servers
- Load balancing done at CSEG servers based on number of avatars



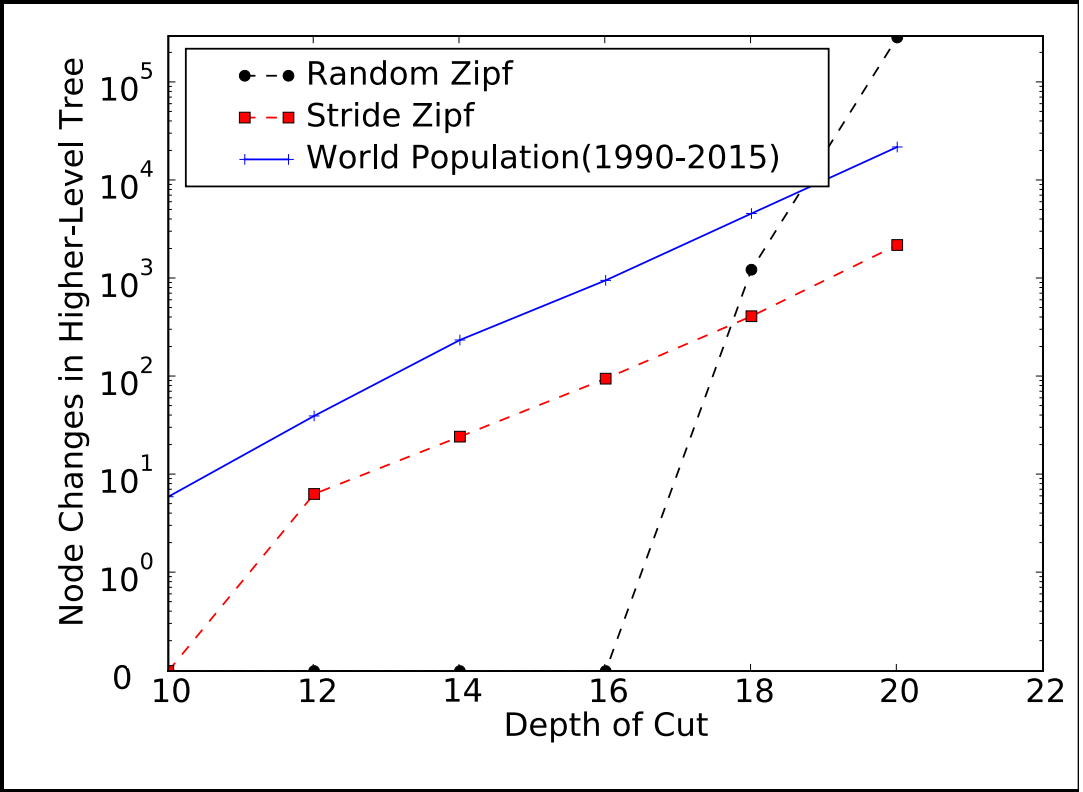
Evaluation

- kd-tree is "split-axis"
  - Not perfect, but still pretty good...
  - Graph characterizes a kd-tree over world population from 1990-2015
    - Depth remains bounded by 41; deeper than a perfect tree by 50%
    - Average depth remains about the same



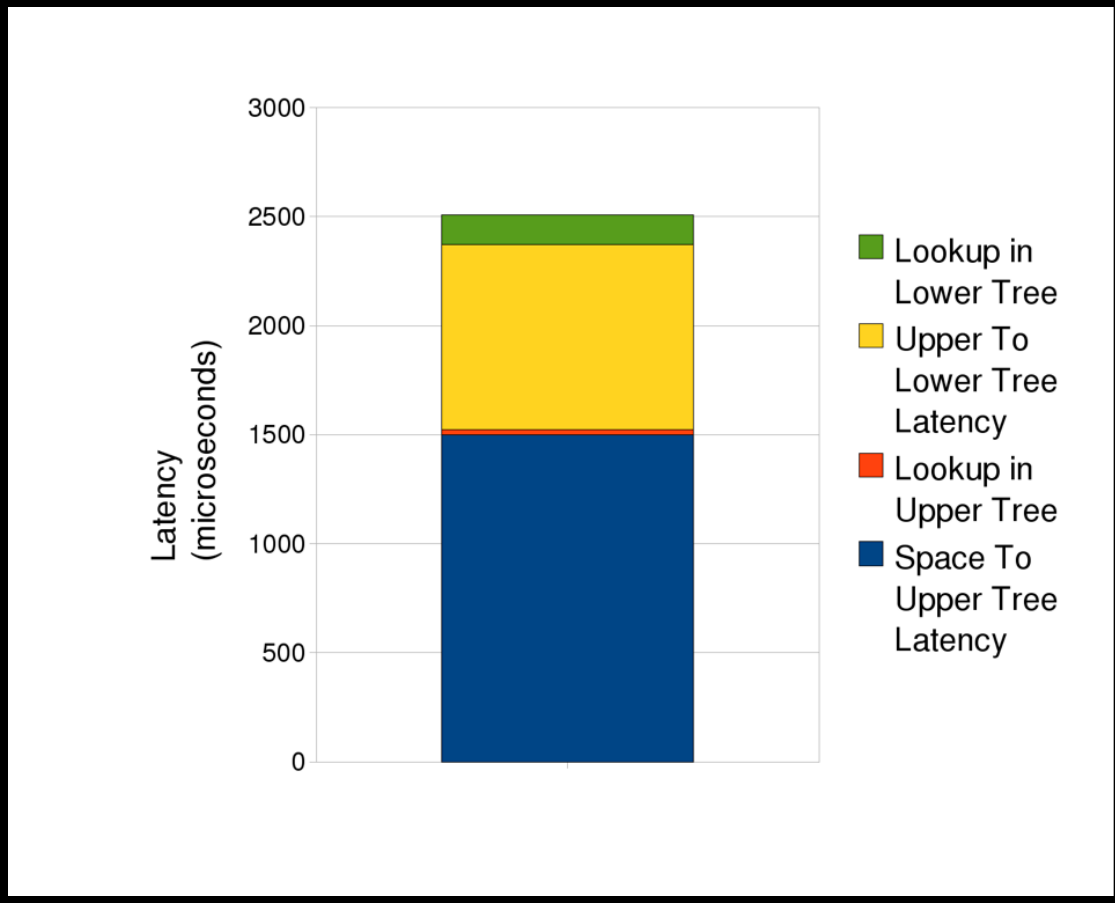
Upper Tree Stability

- With cut at a suitable depth, upper tree remains very stable



Performance

- Currently, latency for a query is around 2.5 ms
  - Most of it is network latency
- With four CSEG servers, currently sustains ~5000 queries per second



Object Segmentation

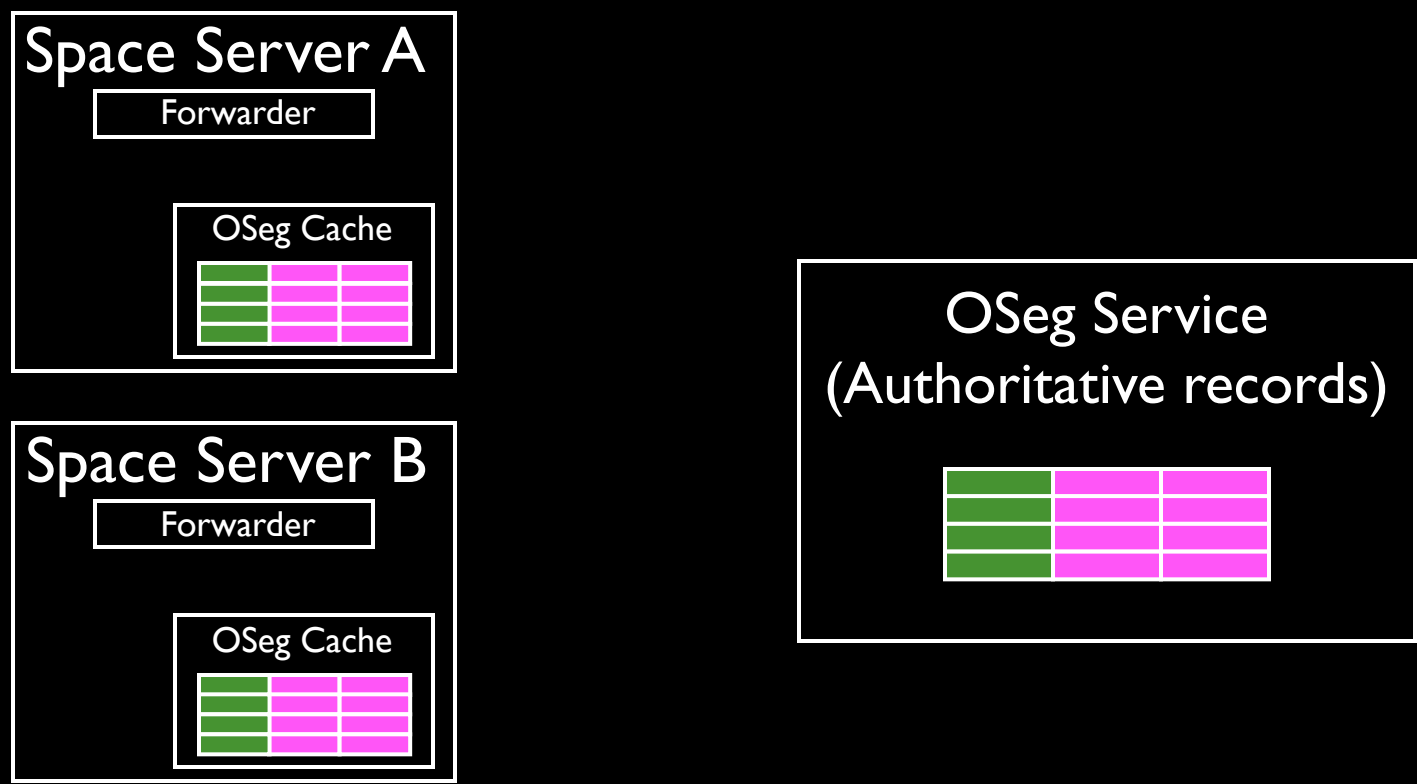
- The space server forwarder must know which space server is authoritative for the recipient.
- OSeg maintains presence to space server mappings:

Presence ID	Server connected to ID	Presence radius

- Each record is ~50B: heavy caching is feasible.
- Stale entries are easy to handle (extra hop).

Object Segmentation (OSeg)

Presence ID	Server connected to ID	Presence radius



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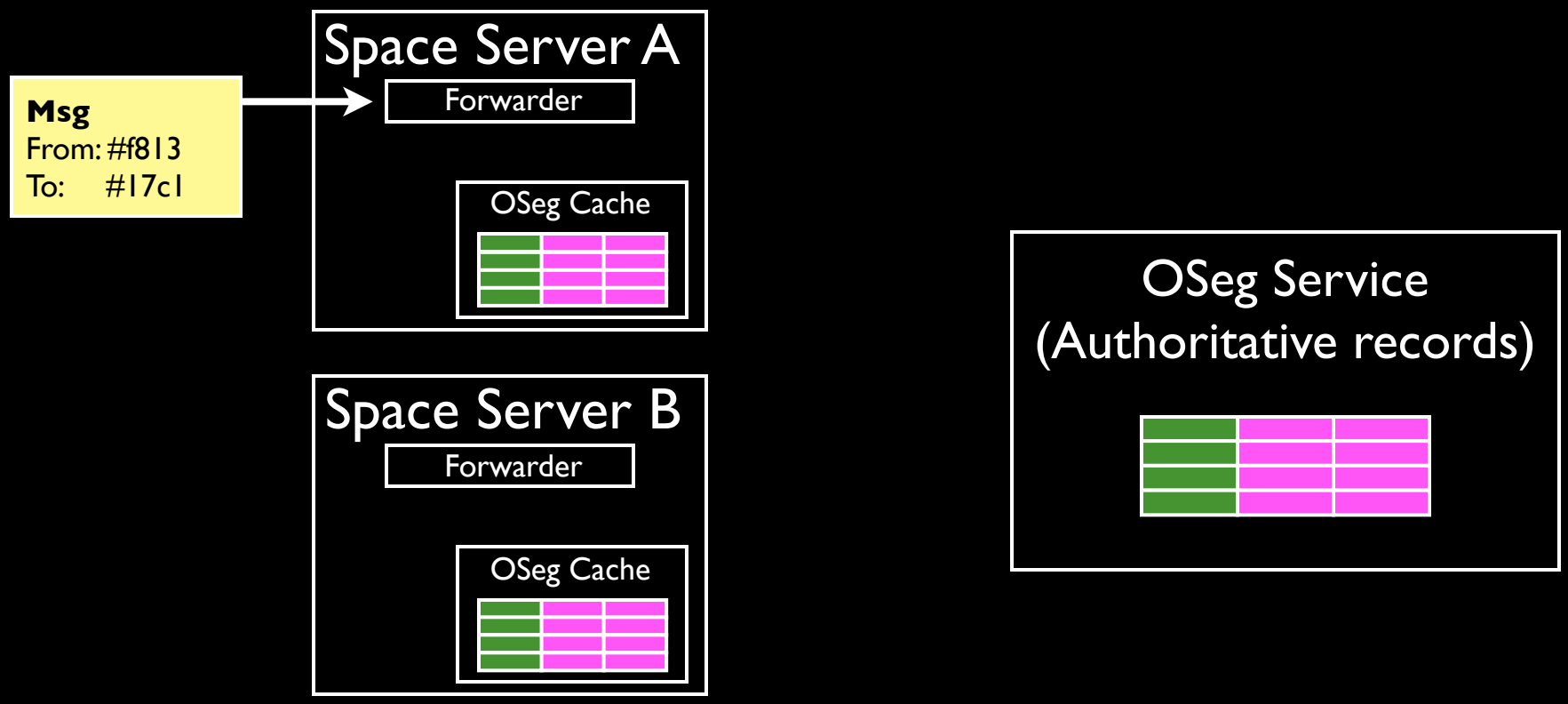
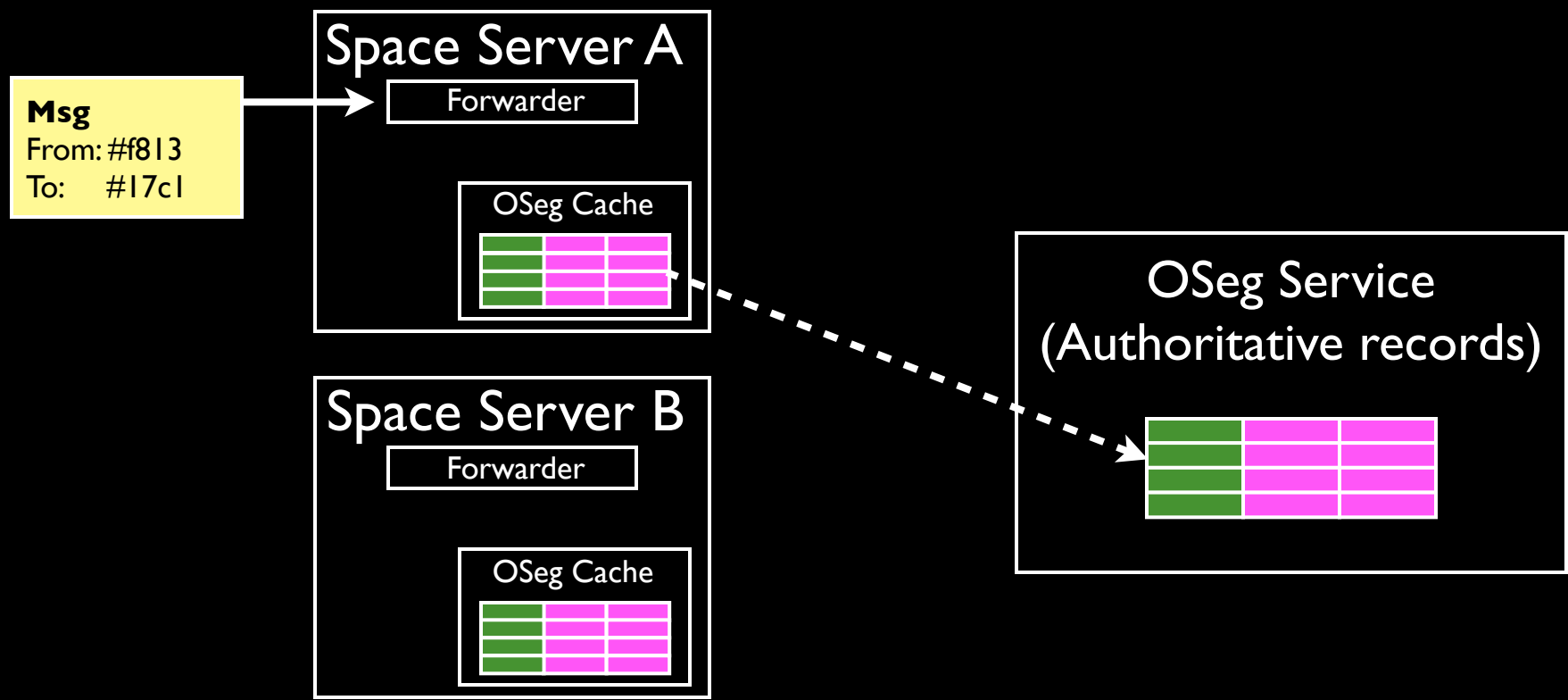


Object Segmentation (OSeg)

Presence ID	Server connected to ID	Presence radius



Object Segmentation (OSeg)

Presence ID	Server connected to ID	Presence radius