Progressive Cache Replacement for Massive Peer-to-Peer WebVR Worlds

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Background

- **Large scale WebVR becomes more popular**
  - E.g., *Google Earth, Virtual Earth, Second Life*
  - WebVR scenes has been more gigantic than before
- **Huge 3D content and limited cache**
  - Clients can not store the whole VE once
  - Cache capacity of PDAs, Mobile phones is less than PCs
- **Current Scenes replacement policies are designed for C/S-DVE, the characteristics of P2P-DVE are not considered**

Related Work :

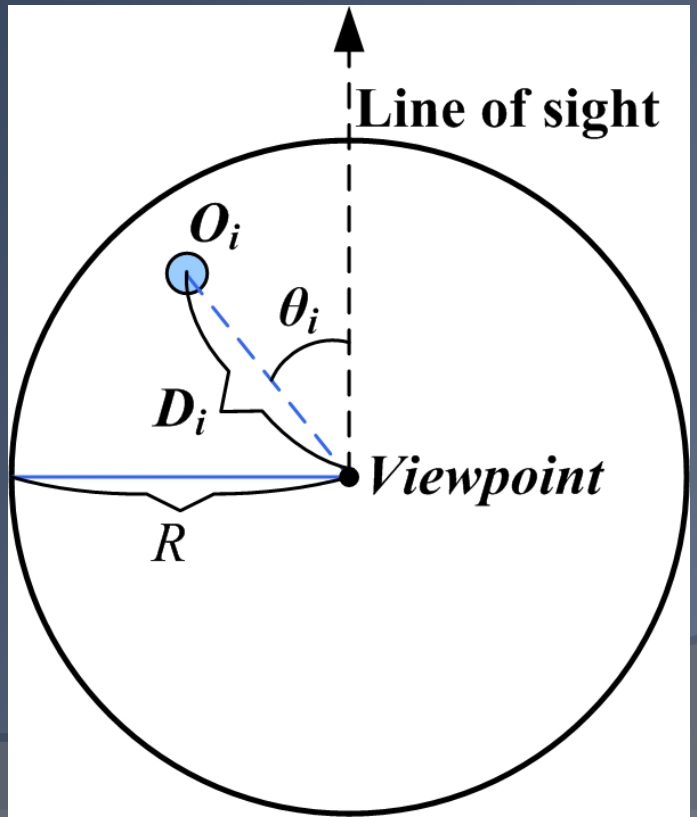
- **LRU、MRU used in database applications**
  - *Principle of locality*
  - Not suitable for DVE well
- **Cache policy in P2P media steaming**
  - **Content are viewed as one-dimensional (i.e., time)**
  - **3D scenes are accessed in terms of viewer's non-linear way**
- **Cache policy in C/S-DVE (e.g. *MRM*)**
- **Scenes replacement in P2P-DVE should consider the relation between viewers and their neighbors**

Our Work--- Progressive Scene Replacement Mechanism (PSRM)

- Concept of *Presevation Degree*
- Composed of :
  - Visual Attention Degree
  - Potential Relavence Degree on AOI neighbors

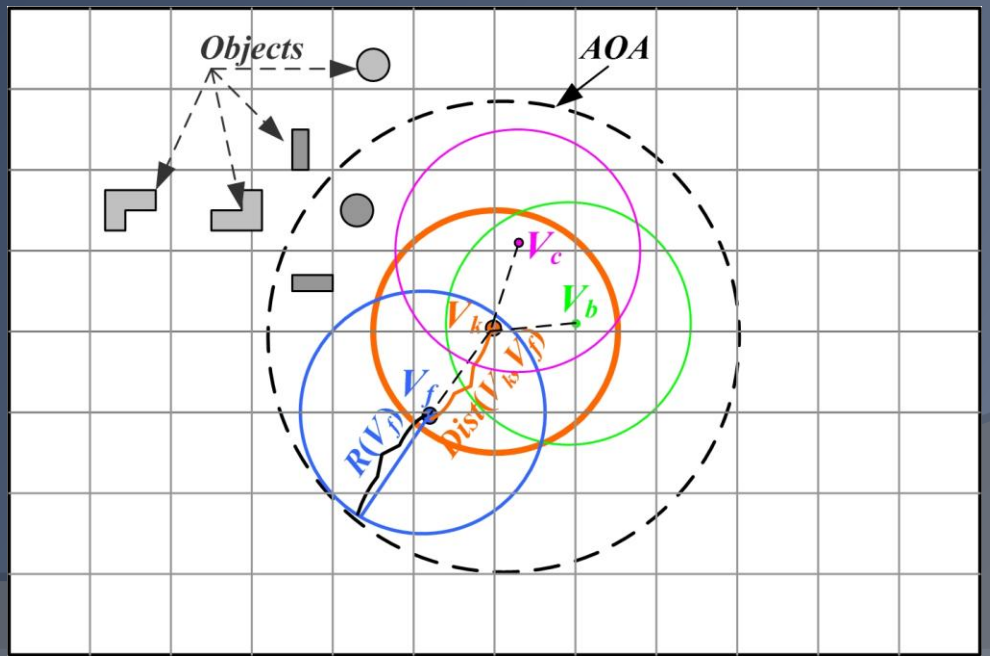
Visual Attention Degree

- **Visual Attention Degree**
  - the farther from the viewer and the larger angle an object is from the viewer's line of sight, the smaller the visual attention degree



Potential Relevance Degree

- **Potential Relevance Degree (PRD)**
  - Removal of an object will bring adverse influence to AOI neighbors's downloading behaviors
  - If an object has been downloaded more times, it can be removed with higher priority



Potential Relevance Degree

- **PRD on one AOI neighbor**
  - **Current formula:**

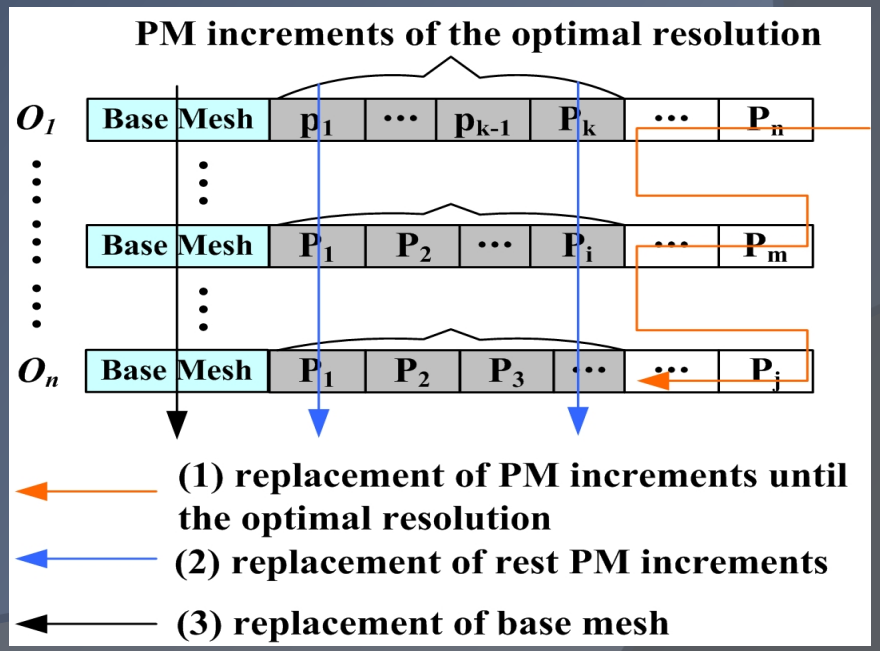
$$R(O_i, V_j) = \frac{1}{\sqrt{1 + DI_{V_j}(O_i) + DB_{V_j}(O_i)}}$$

  - **Average PRD on AOI neighbors**

$$R^{AOI_k}(O_i) = \sum_{i=1}^{n} \frac{R(O_j, V_i)}{n}$$

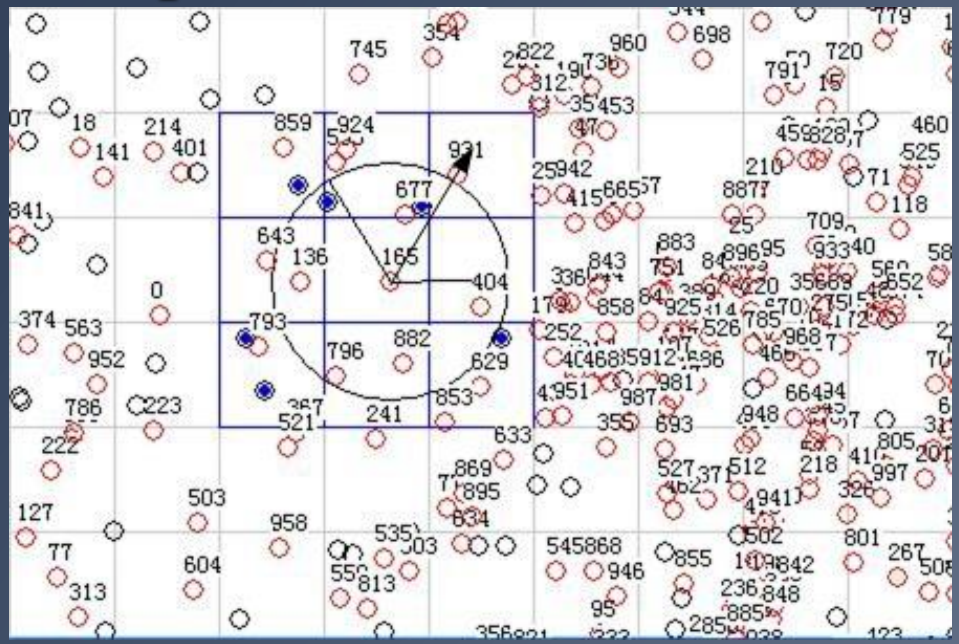
Removal Policy

- Preservation Degree =
  visual attention degree + potential relevance degree
- How to remove 3D content in PSRM?
  - Remove PM increments until the optimal resolution
  - Remove remaining PM increment
  - Remove base mesh



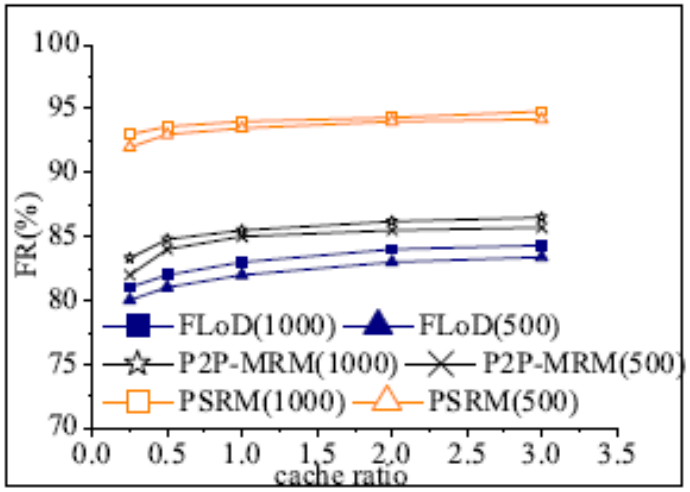
Experiment

- Experimental platform based on ASCEND project



- We compare three scene replacement mechanisms：
  - P2P-MRM
  - Distance-based replacement in FLoD
  - PSRM

Experimental Results



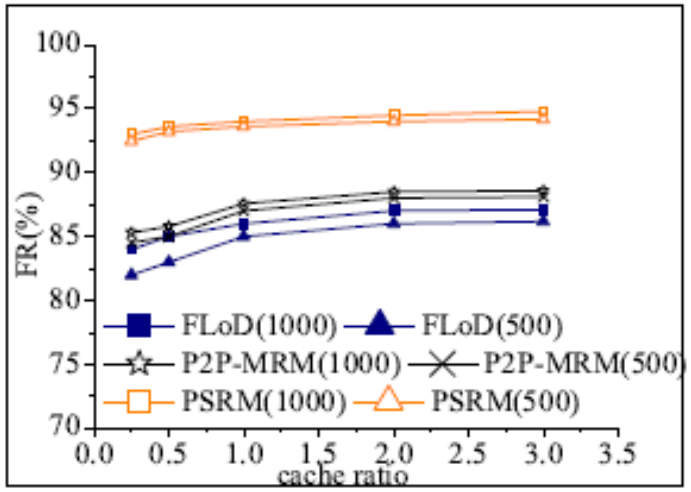
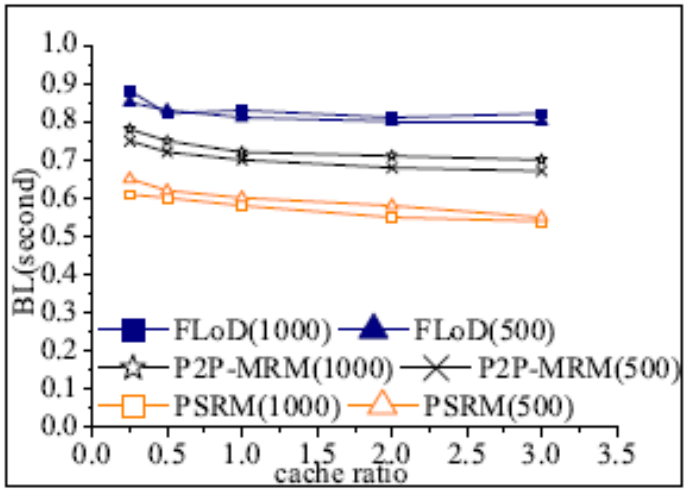
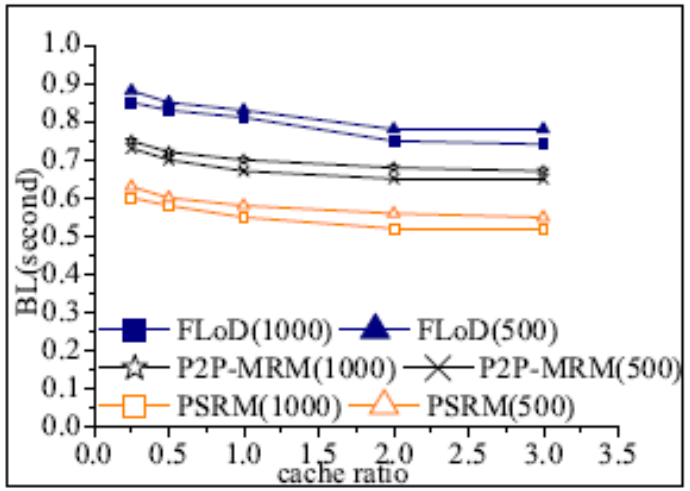


Fig. 5: Effect of cache ratio on fill ratio (the left is RW and the right is CW)





Experimental Results

- **Requests to Server**

TABLE II: Requests to server per step in RW

cache ratio	FLoD-500	P2P-MRM500	PSRM-500	FLoD-1000	P2P-MRM1000	PSRM-1000
0.25	549	496	114	543	497	112
0.5	544	499	106	541	495	109
1	542	497	103	546	496	108
2	545	495	104	545	492	105
3	544	494	105	545	493	104

TABLE III: Requests to server per step in CW

cache ratio	FLoD-500	P2P-MRM500	PSRM-500	FLoD-1000	P2P-MRM1000	PSRM-1000
0.25	540	492	112	538	491	113
0.5	543	490	104	536	486	105
1	539	496	101	535	485	104
2	534	491	102	532	486	101
3	535	493	101	530	487	102

Future Work

- Optimal weights of each factor of the preservation degree
- How clients should interact with content servers collaboratively
- More realistic user traces and bandwidth distributions …

Thanks

Q&A

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