Dsync: a Lightweight Delta Synchronization Approach for Cloud Storage Services

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Outline

- Background and motivation
- Design and implementation
- Performance evaluation
- Conclusion

Background and motivation

File synchronization

- Full sync:

  Simple, but not bandwidth-efficient

- Delta sync:

  Suitable for frequently modified files

  1. Fix-Sized Chunking:

     High compute overhead for comparing

  2. Content-defined Chunking:

     Lower compute overhead but require local buffer

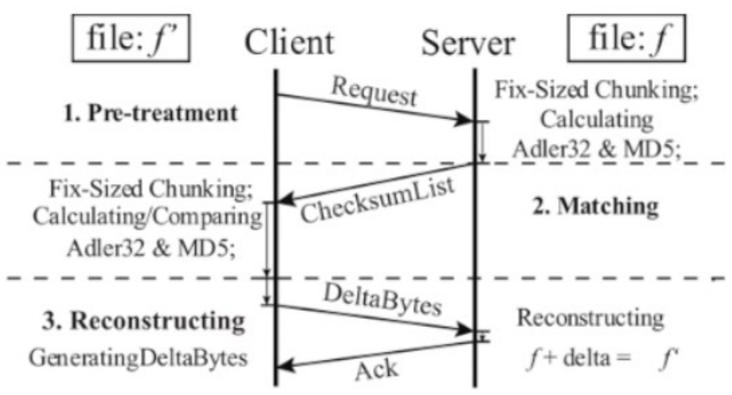
Source	Full Sync[1]	*Delta Sync*	
		Local Buffer	*Chunking*$_2$ *Methods*
DropBox (W/A) [8][3]	×	√	FSC
Seafile (W) [6]	×	√	CDC
Seafile (A) [6]	√	×	×
GoogleDrive (W/A) [8]	√	×	×
OneDrive (W/A) [8]	√	×	×
`rsync` [5]	×	×	FSC
DeltaCFS [34]	×	×	FSC
PandaSync [28]	√*	×	FSC
WebSync [32]	×	×	FSC
QuickSync [8]	×	√	CDC
LBFS [23]	×	×	CDC
UDS [20]	×	×	FSC
Dsync	×	×	CDC

1 √: full sync, ×: delta sync, and √*: selective full sync.
2 FSC: Fix-Sized Chunking, CDC: Content-Defined Chunking.
3 W: windows client, A: android client.

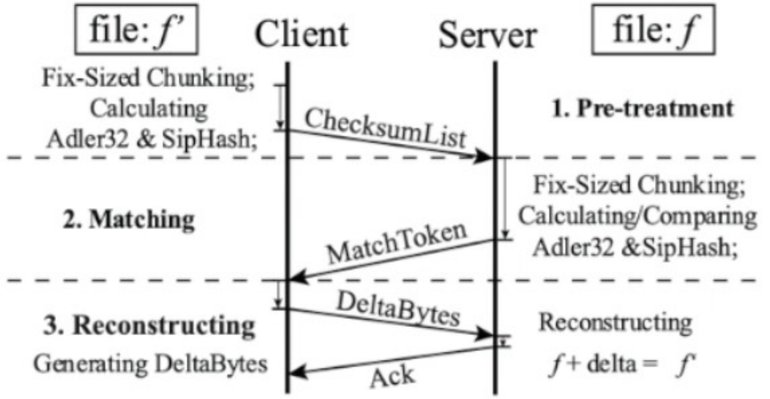
Background and motivation

WebR2sync+:
For low compute and storage devices.

But still need to compare chunks byte by byte!



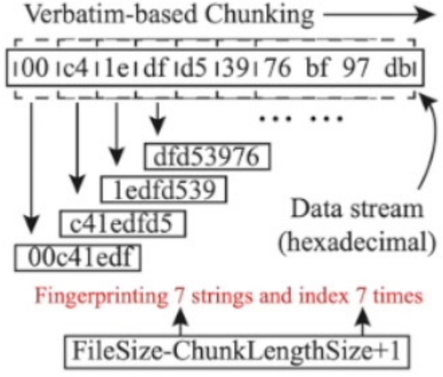
rsync

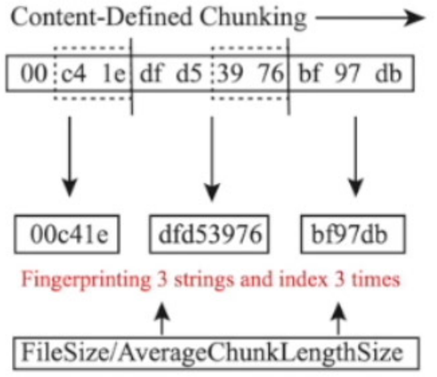


WebR2sync+

Insight of Dsync:

CDC-based comparing to decrease overhead



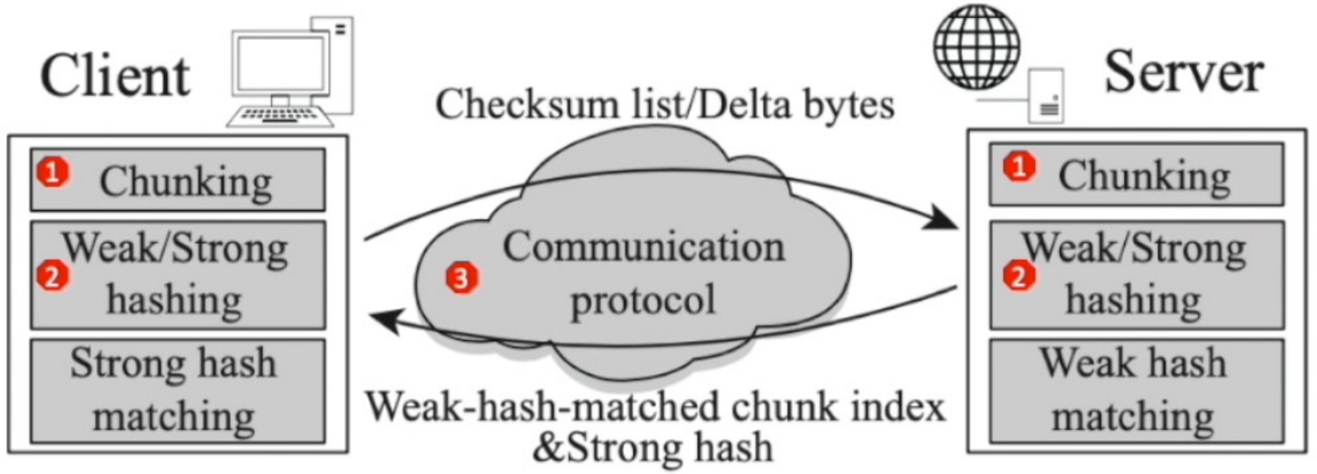


Design and implementation - Overview

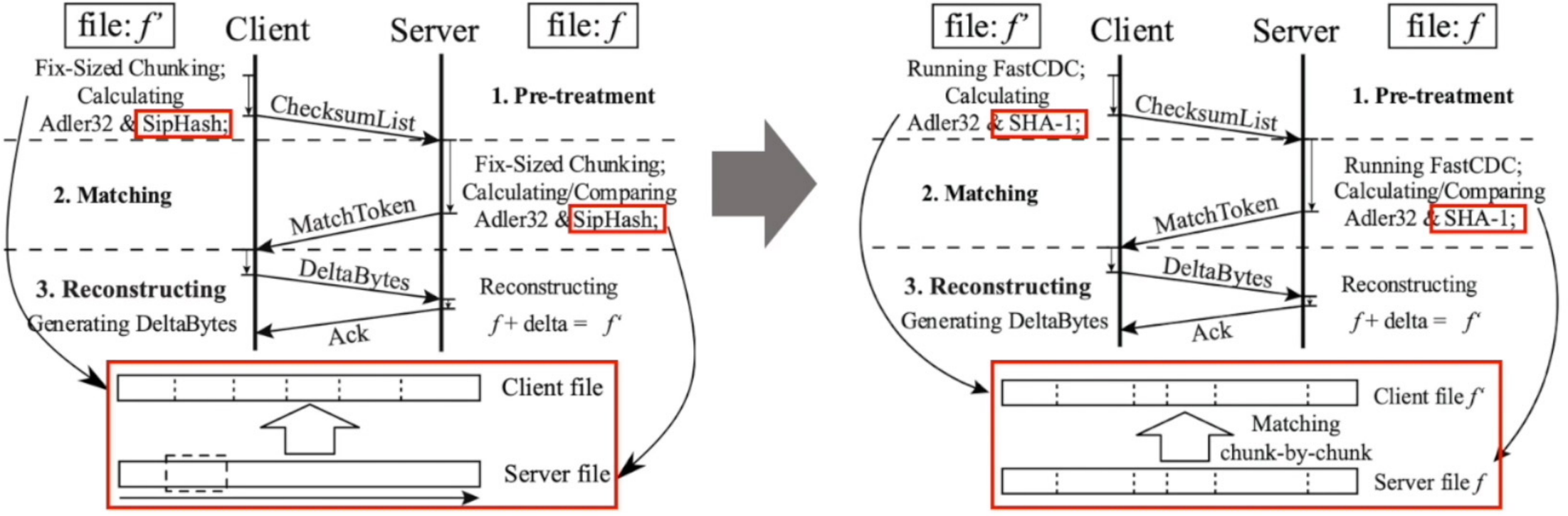
1. Fix-size chunking to content-defined chunking

2. Newer hash function with low overhead

3. Communication protocol
   - Reduce compute overhead
   - Reduce metadata transmission



Design and implementation - Baseline



1. Replace SipHash with SHA-1

2. Replace Fix-Sized Chunking with Content-Defined Chunking (CDC)

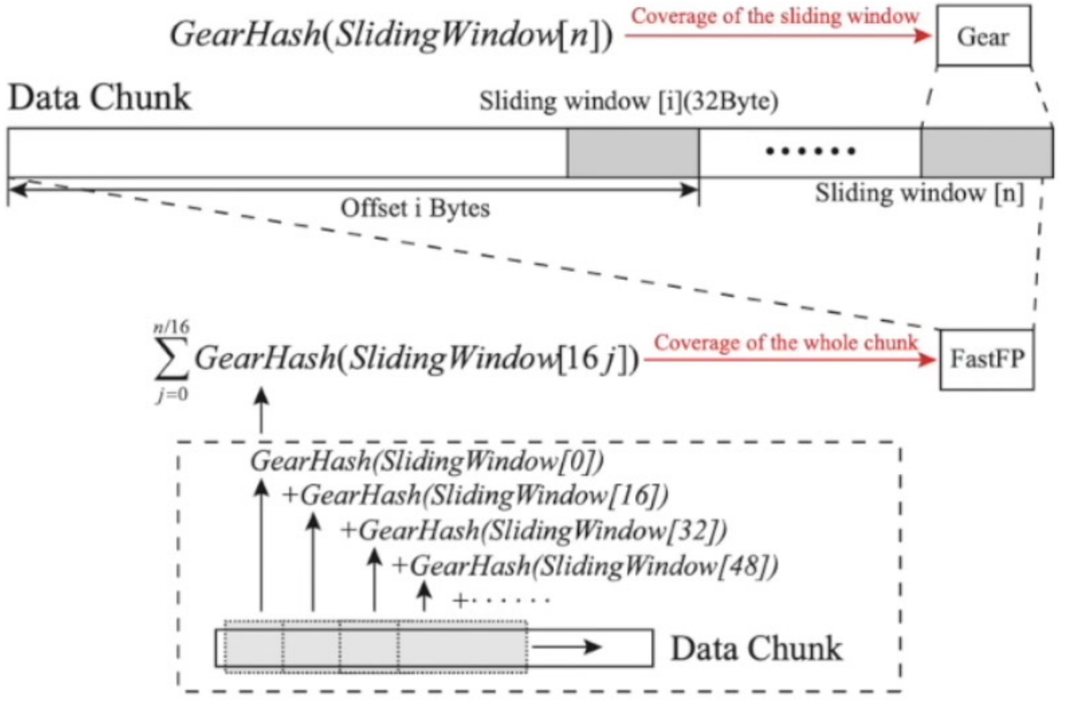
Design and implementation - FastFp

1. Reduce hash compute overhead:

Generate chunk fingerprint from rolling hash

2. Lower hash collision:

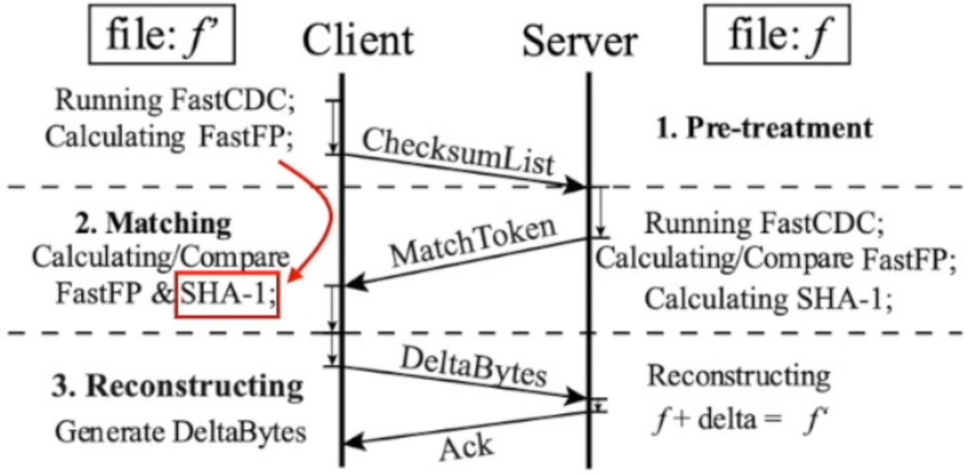
Integrate the influence of sliding windows by summing them up



Design and implementation – Communication protocol

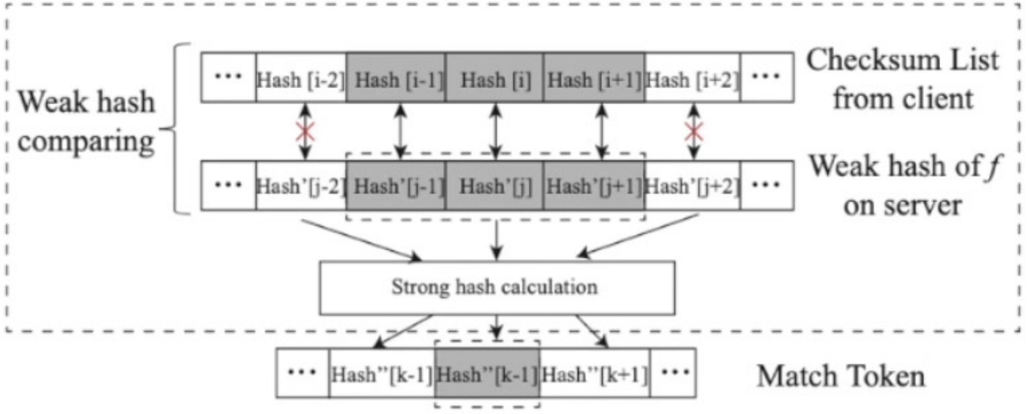
1. Reduce compute overhead:

   Shifting client strong hash calculation



2. Reduce metadata transmission:

   Merging contiguously duplicate chunks



Evaluation

Platform:

Server
NodeJS v12.8@Quard-core virtual machine(16GB memory) ,100Mbps network

PC client
Chrome v76.0(Windows)@Intel i7-7700 CPU, 16GB memory PC

Mobile phone client
Chrome v74.0(Android)@6GB RAM, Huawei Honor V10

Evaluation

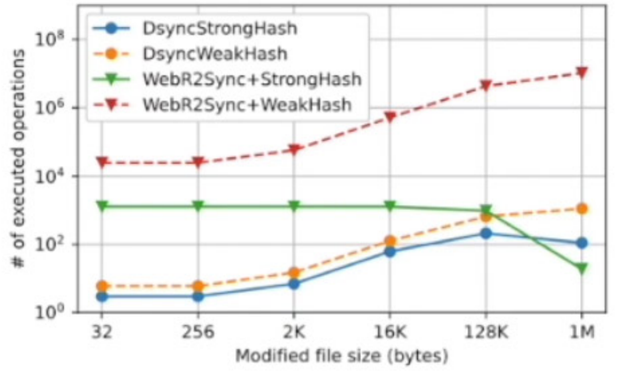
Compared with Adler32, FastFp:

Equivalent collision ratio,
But higher throughput

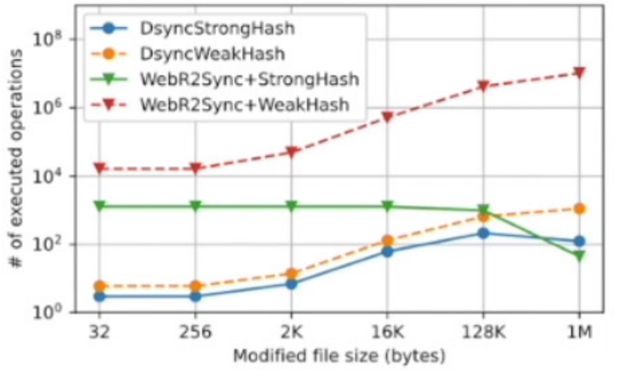
THROUGHPUT AND COLLISION RATIO COMPARISON. HERE FASTFP IS EVALUATED WITH DIFFERENT CONFIGURATIONS: "⊕" IS FOR "XOR", "+" IS FOR "PLUS", WINDOW SLIDING DISTANCE IS OF 8B, 16B, 32B.

Algorithms	Thpt (MB/s)	Hash collision ratio under different random file size		
		100GB	10GB	1GB
Adler32	295.6	2.3×10^{-10}	2.3×10^{-10}	2.4×10^{-10}
Gear	527.8	6.8×10^{-7}	6.8×10^{-7}	6.8×10^{-7}
FastFp(⊕ 8B)	460.0	2.2×10^{-10}	2.2×10^{-10}	3.1×10^{-10}
FastFp(⊕16B)	459.2	2.3×10^{-10}	2.3×10^{-10}	1.5×10^{-10}
FastFp(⊕32B)	460.4	2.2×10^{-10}	2.4×10^{-10}	3.1×10^{-10}
FastFp(+ 8B)	396.9	2.3×10^{-10}	2.4×10^{-10}	2.8×10^{-10}
FastFp(+16B)	397.5	2.3×10^{-10}	2.2×10^{-10}	1.8×10^{-10}
FastFp(+32B)	409.6	2.3×10^{-10}	2.3×10^{-10}	4.0×10^{-10}

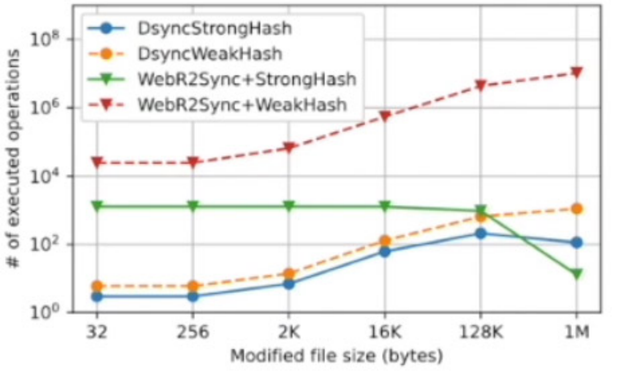
Evaluation



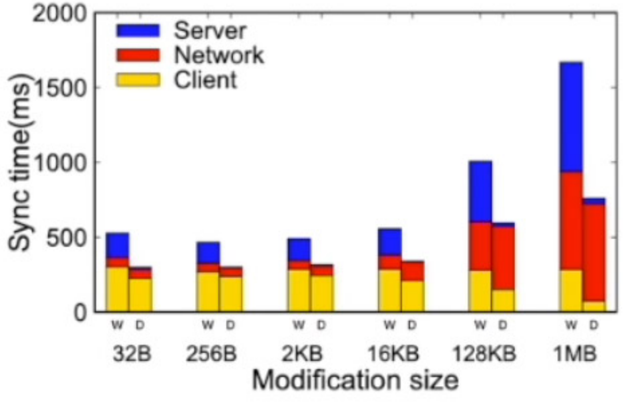
(a) Cut.



(b) Insert.



(c) Inverse.



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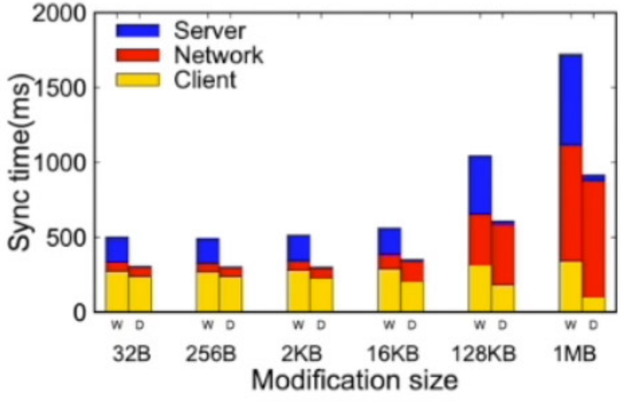
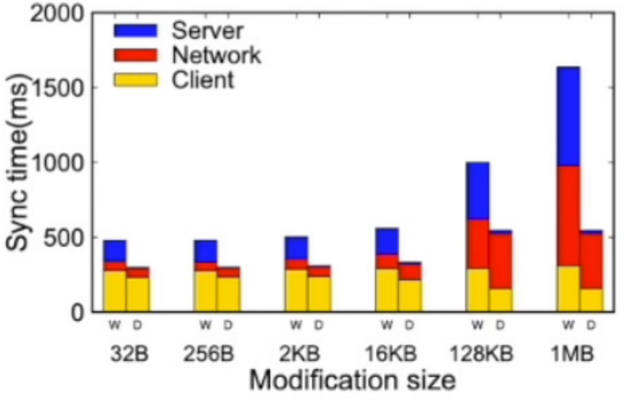


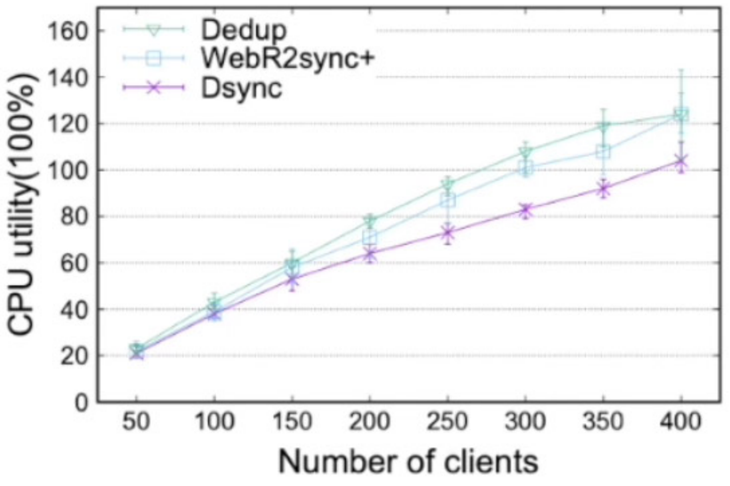
(b) Insert.



(c) Inverse.

Lower overhead and runs faster than WebR2sync+

Evaluation



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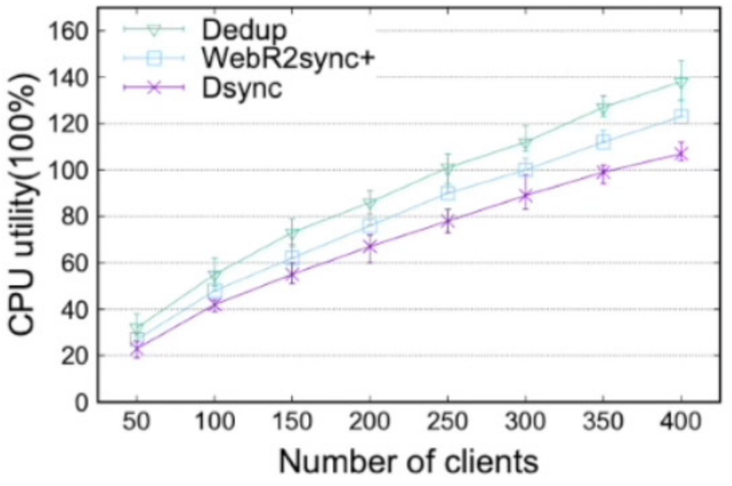
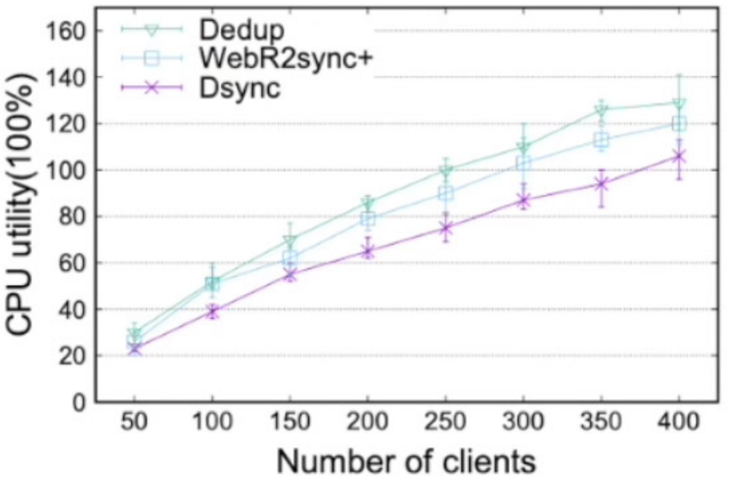


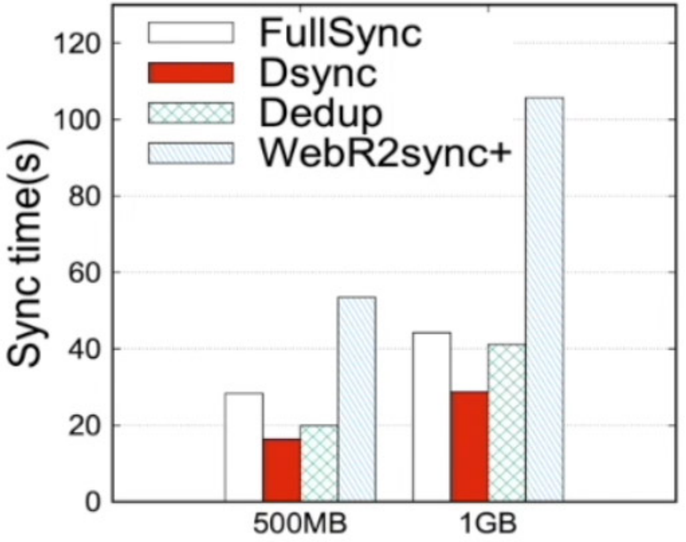
(b) Insert.



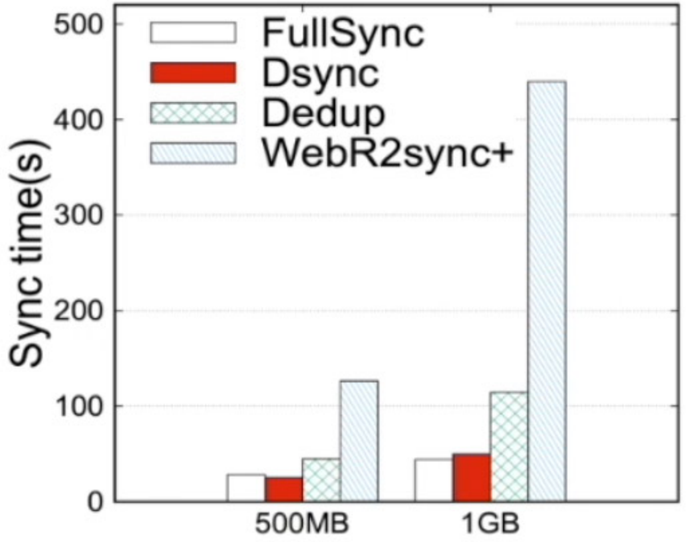
(c) Inverse.

Better scalability than LBFS-based (Dedup) and rsync-based approach (webR2sync+)

Evaluation – Under high bandwidth network



(a) Modification ratio of 1%.



(b) Modification ratio of 30%.

Dsync runs no worse than full sync in any condition!

Conclusion

- Develop a fast, weak hash named FastFp
- Redesign delta sync protocol by exploiting deduplication locality, and hash properties
- 2X~8X faster and 30%~50% higher concurrency than either state-of-the-art rsync-based or deduplication based approach

Thanks for watching!