



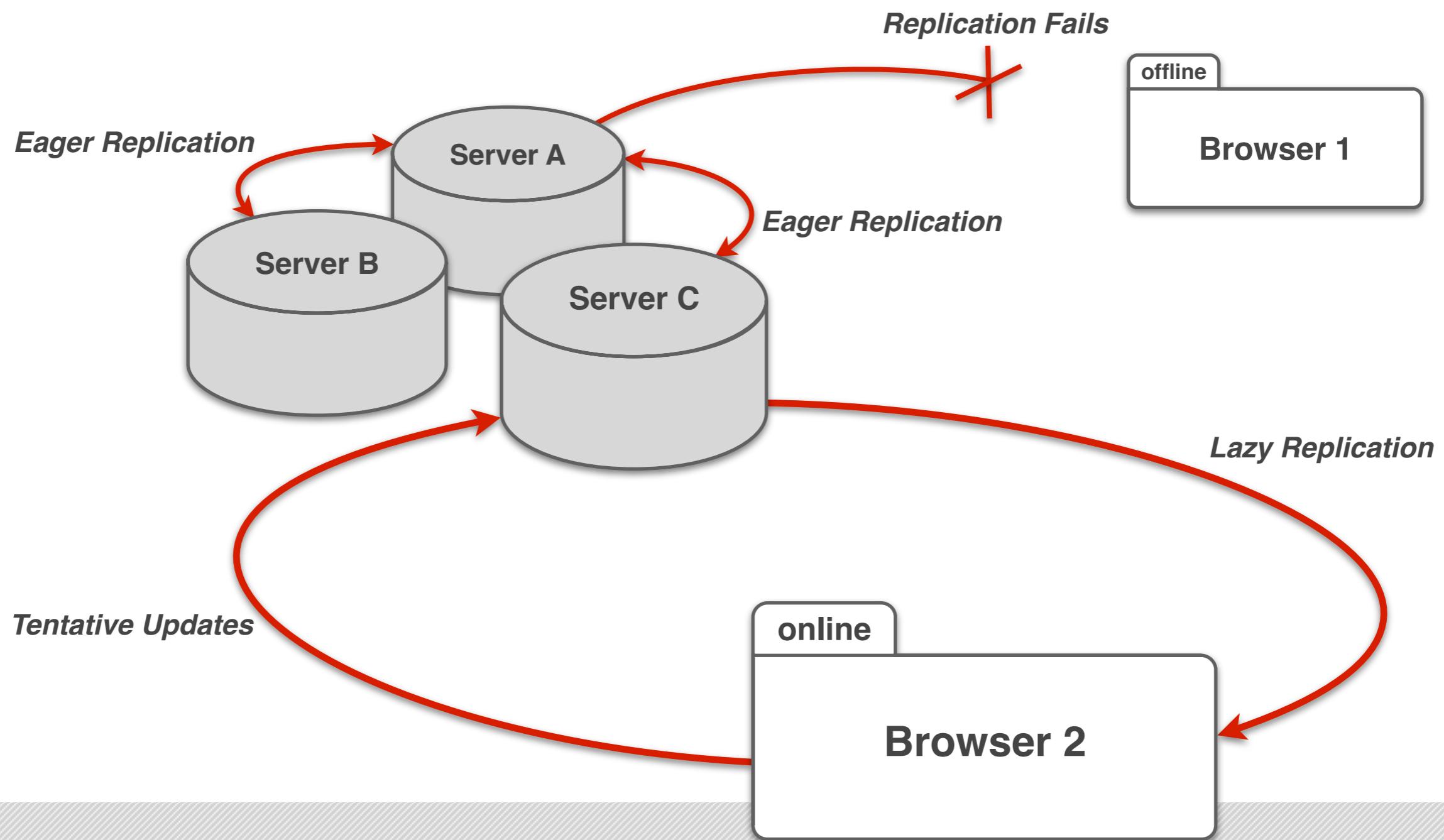
# Data Replication for Offline Web Applications

## Optimizing Synchronization, Persistence and Conflict Resolution

- › Master Thesis Samuel Esposito
- › Supervisors: Prof.dr. M. Aiello, MSc A.C. Emerencia
- › Second reader: Prof. dr. ir. P. Avgeriou

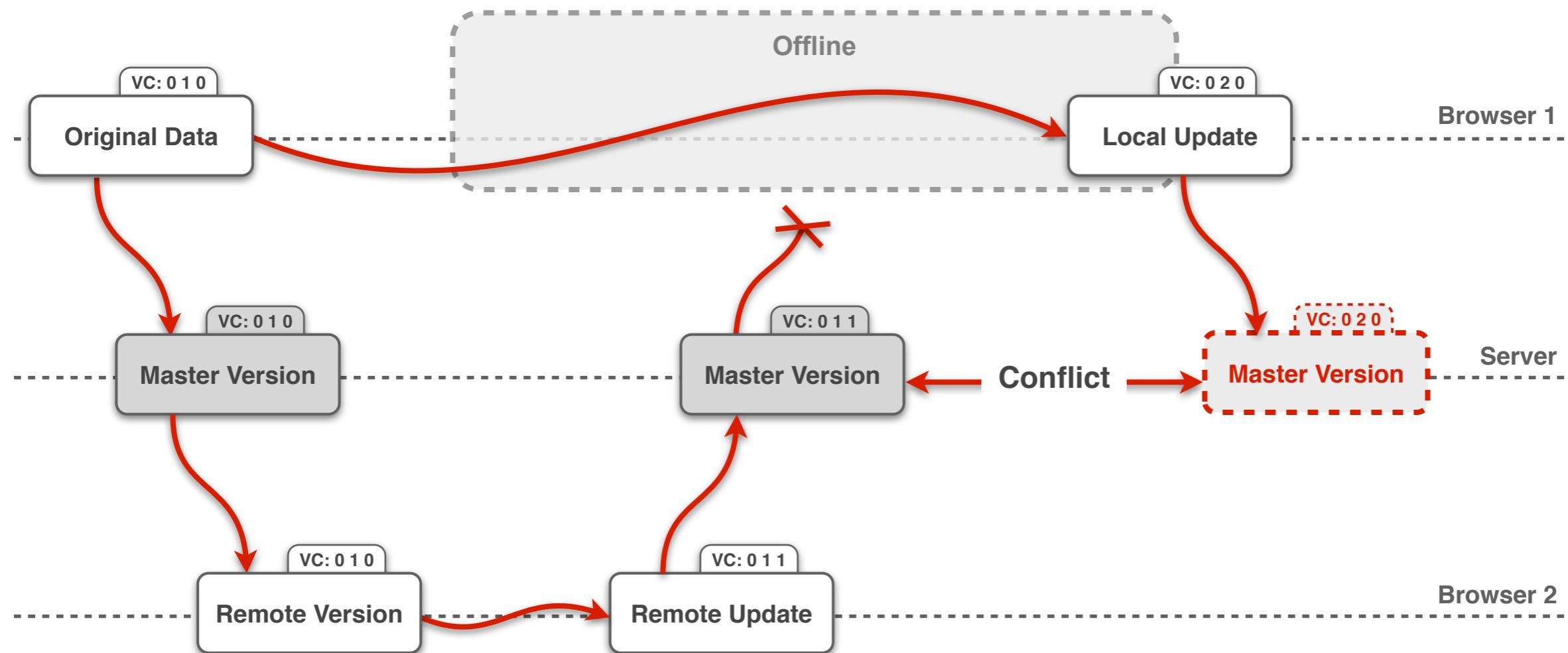


# Two-tier architecture



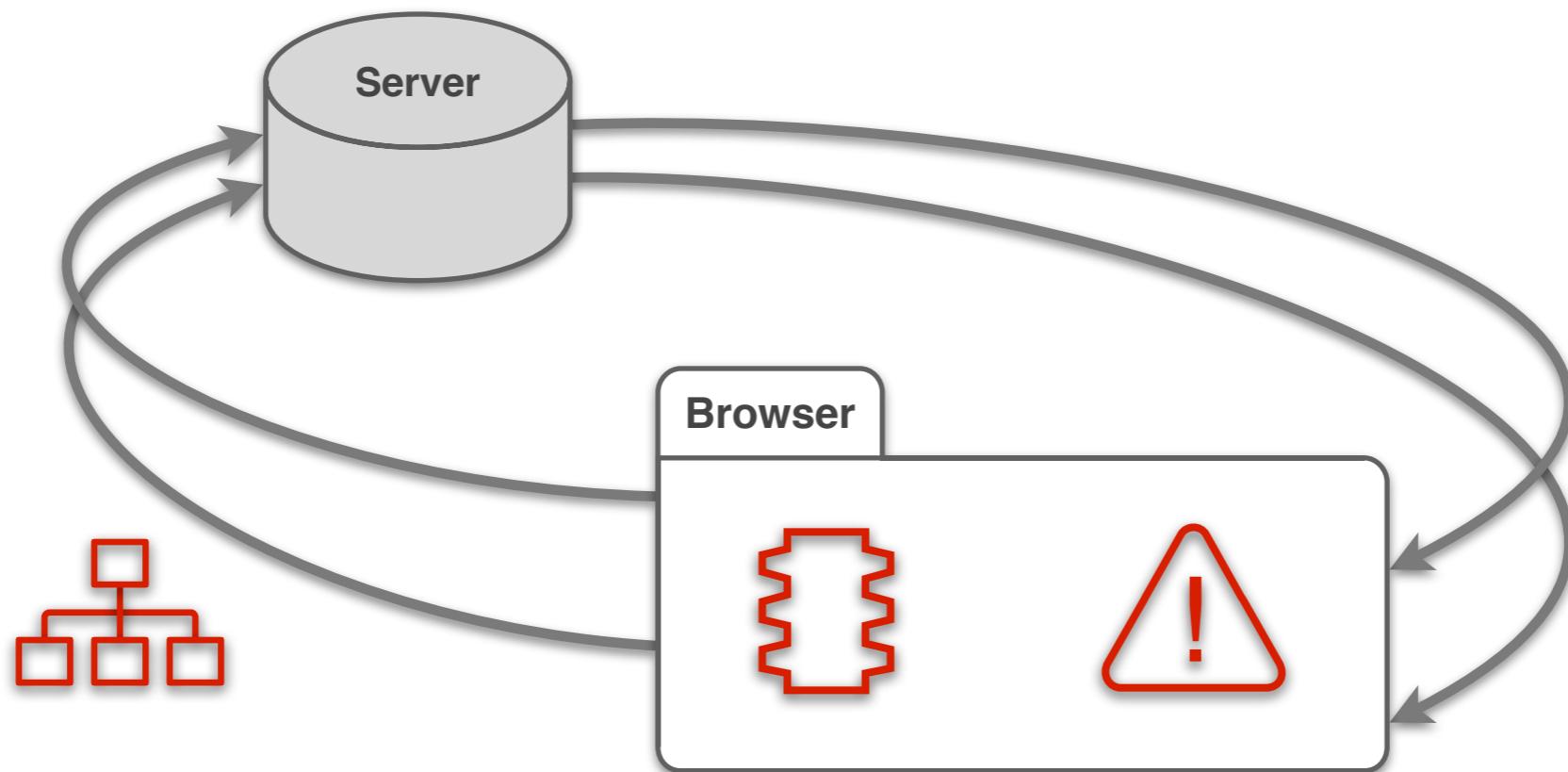


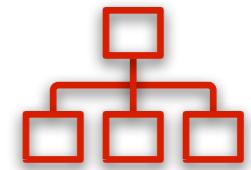
# On the origin of conflicts



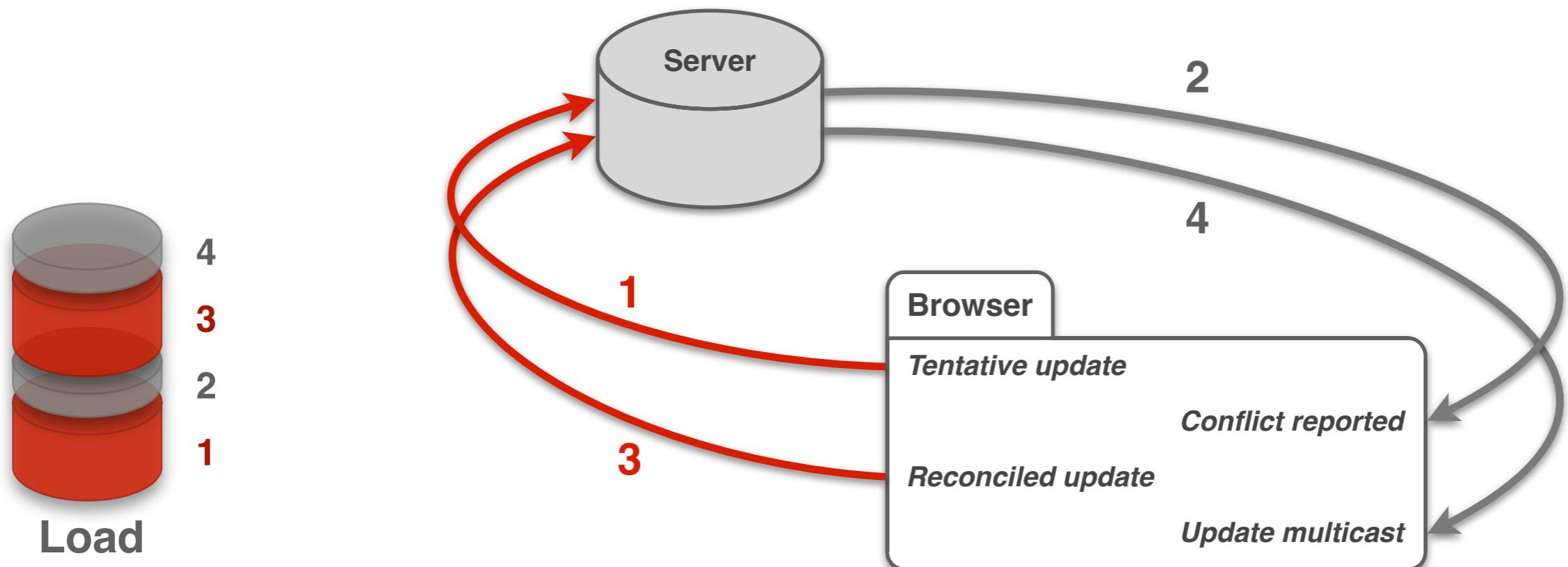


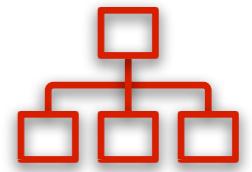
# Optimizations



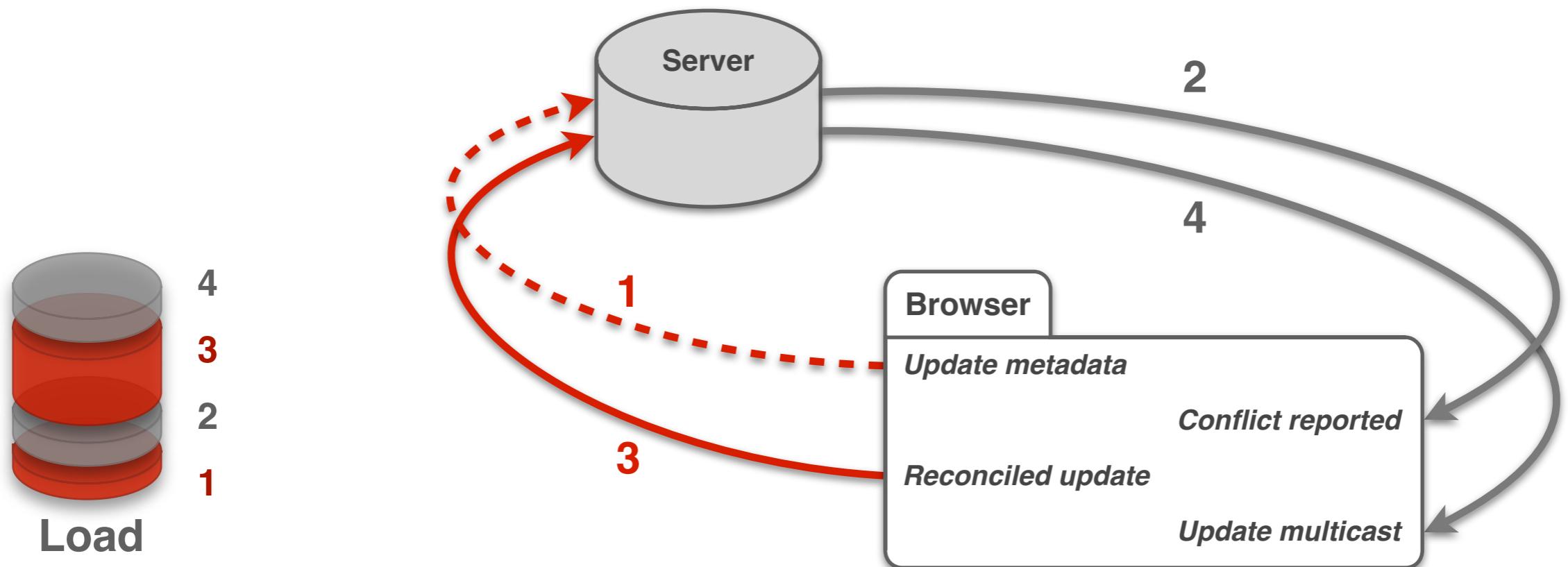


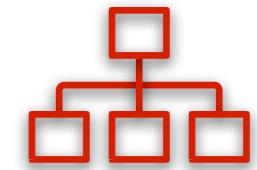
# Network load: traditional synchronization



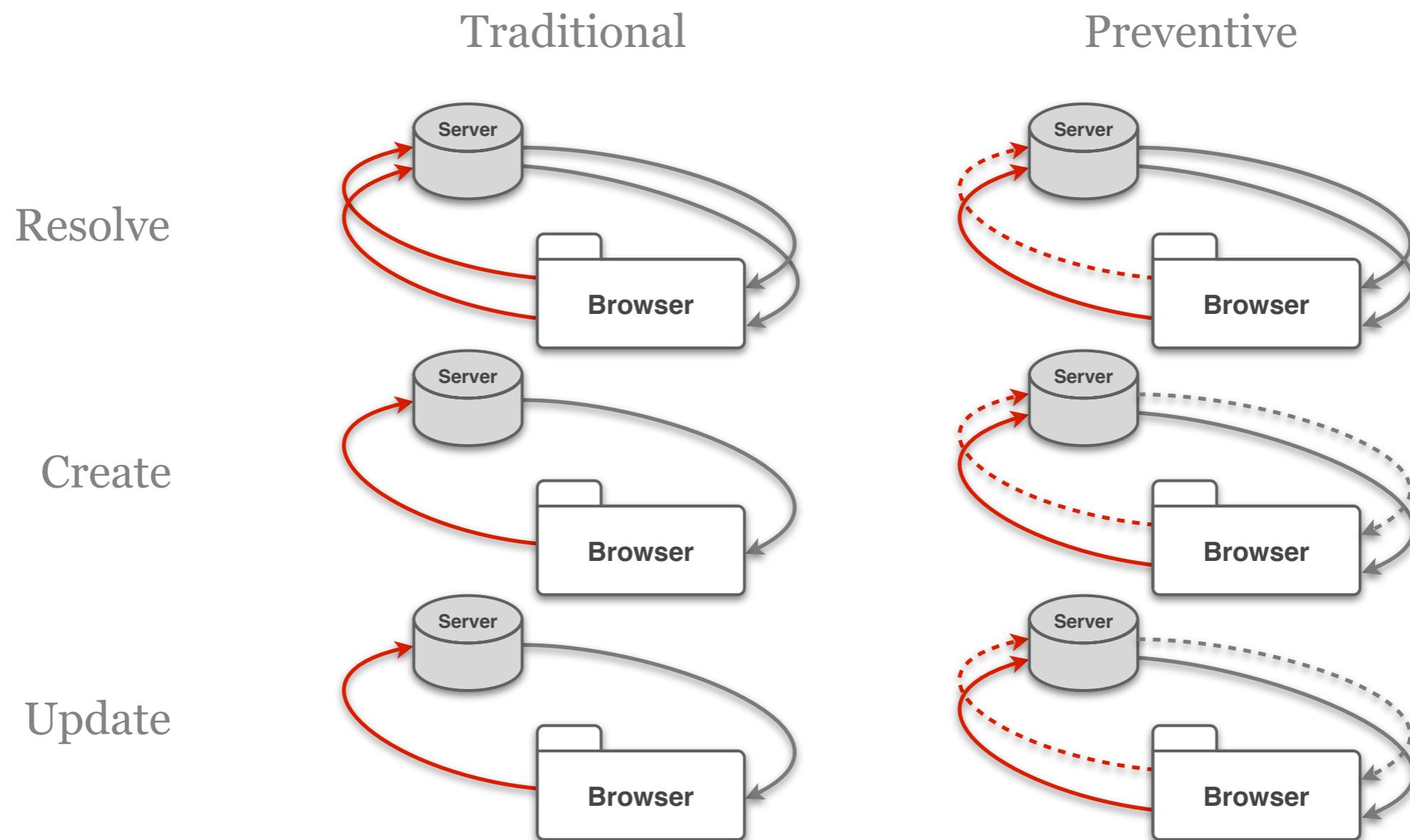


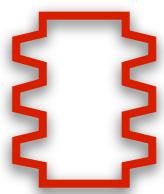
# Network load: preventive reconciliation



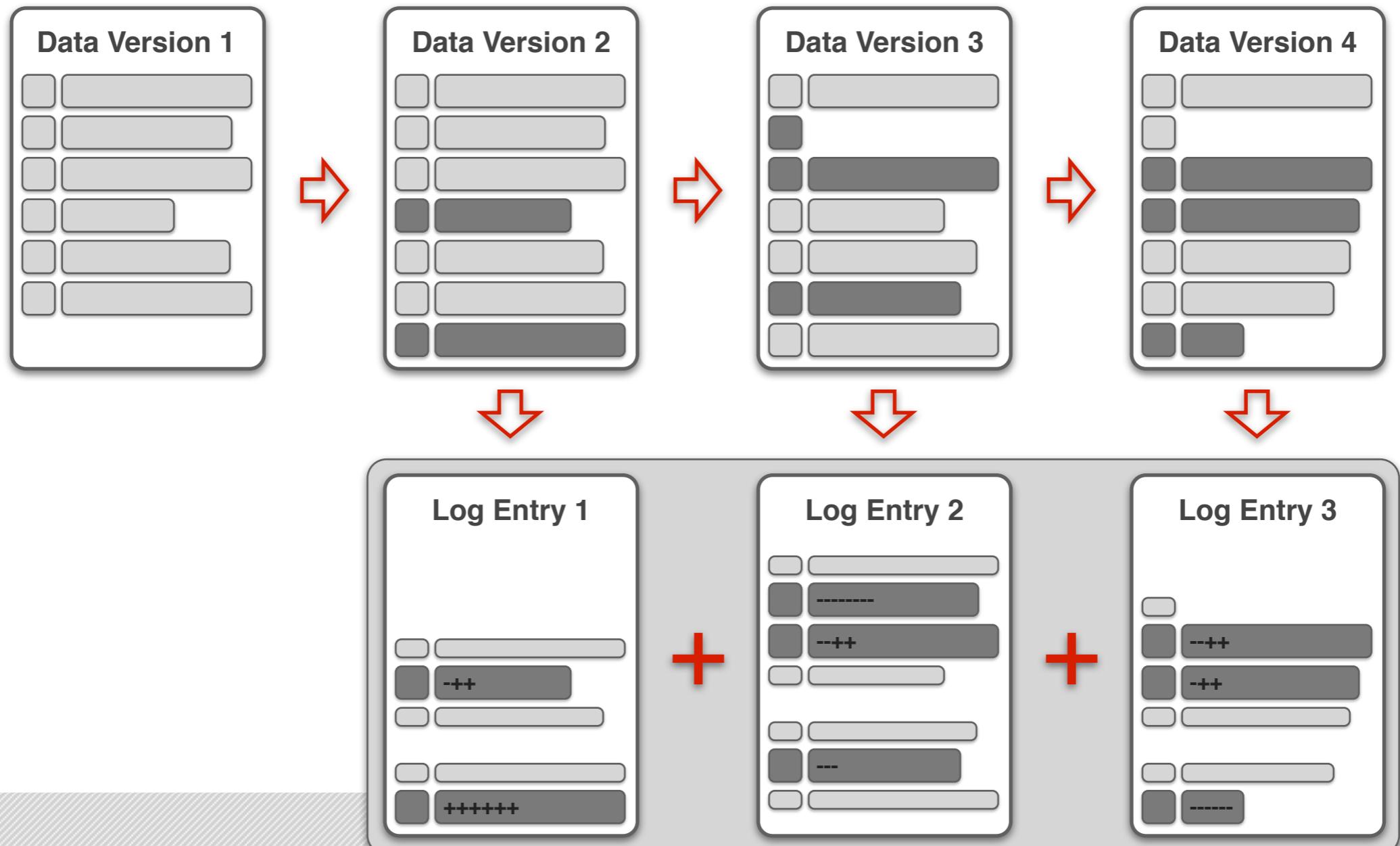


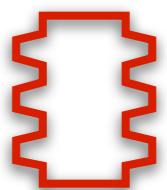
# Network load: preventive reconciliation



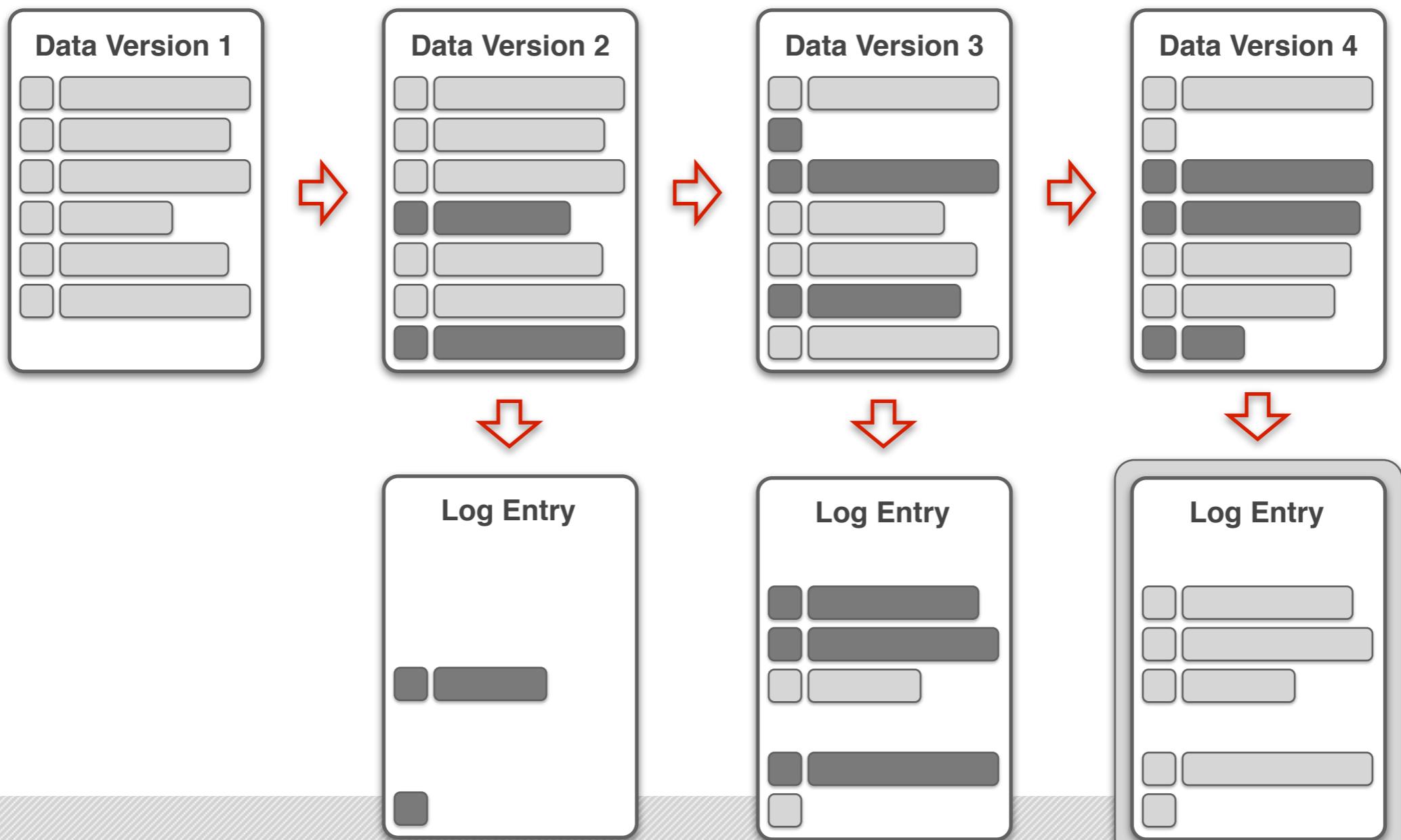


# Memory footprint: incremental browser log



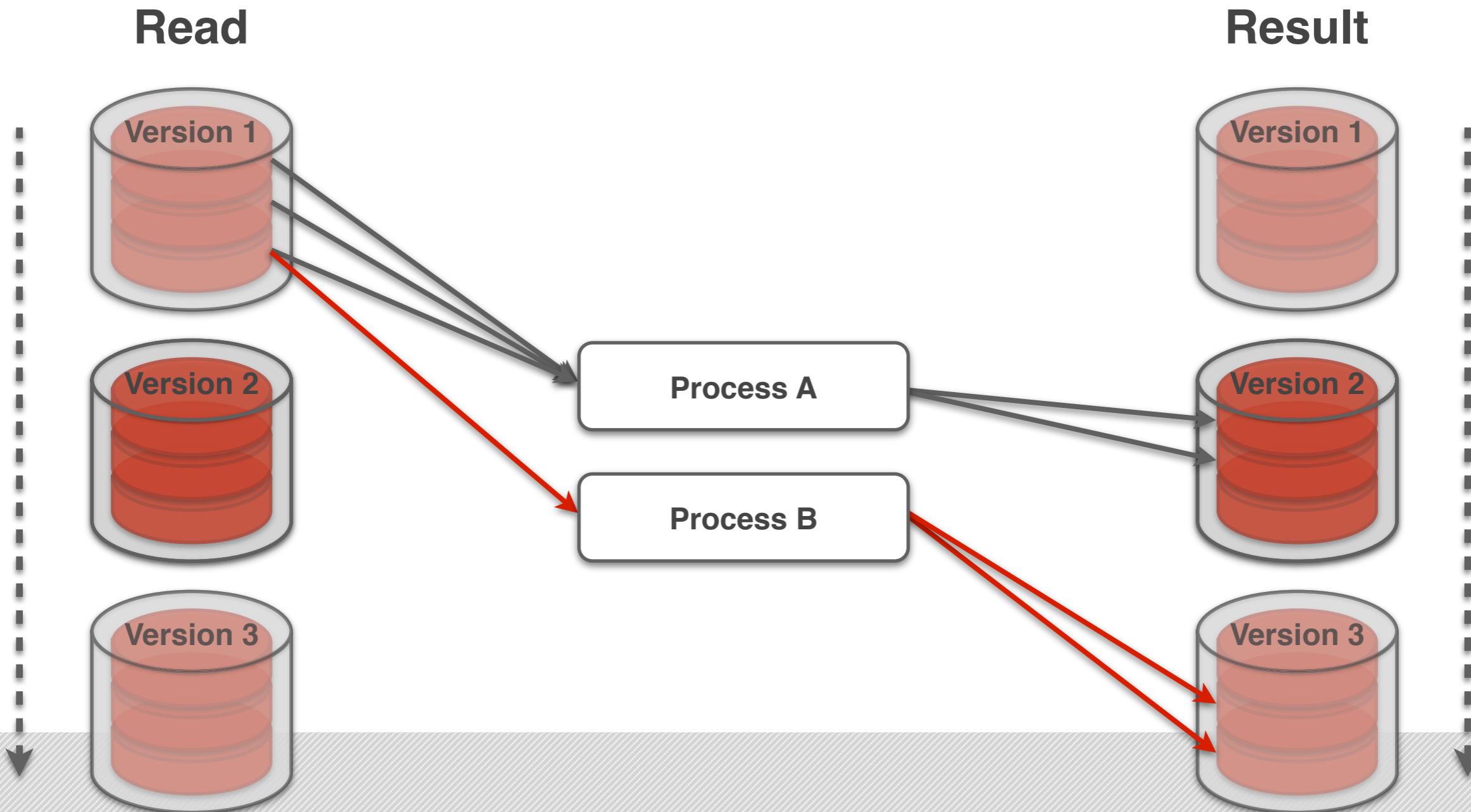


# Memory footprint: merged browser log



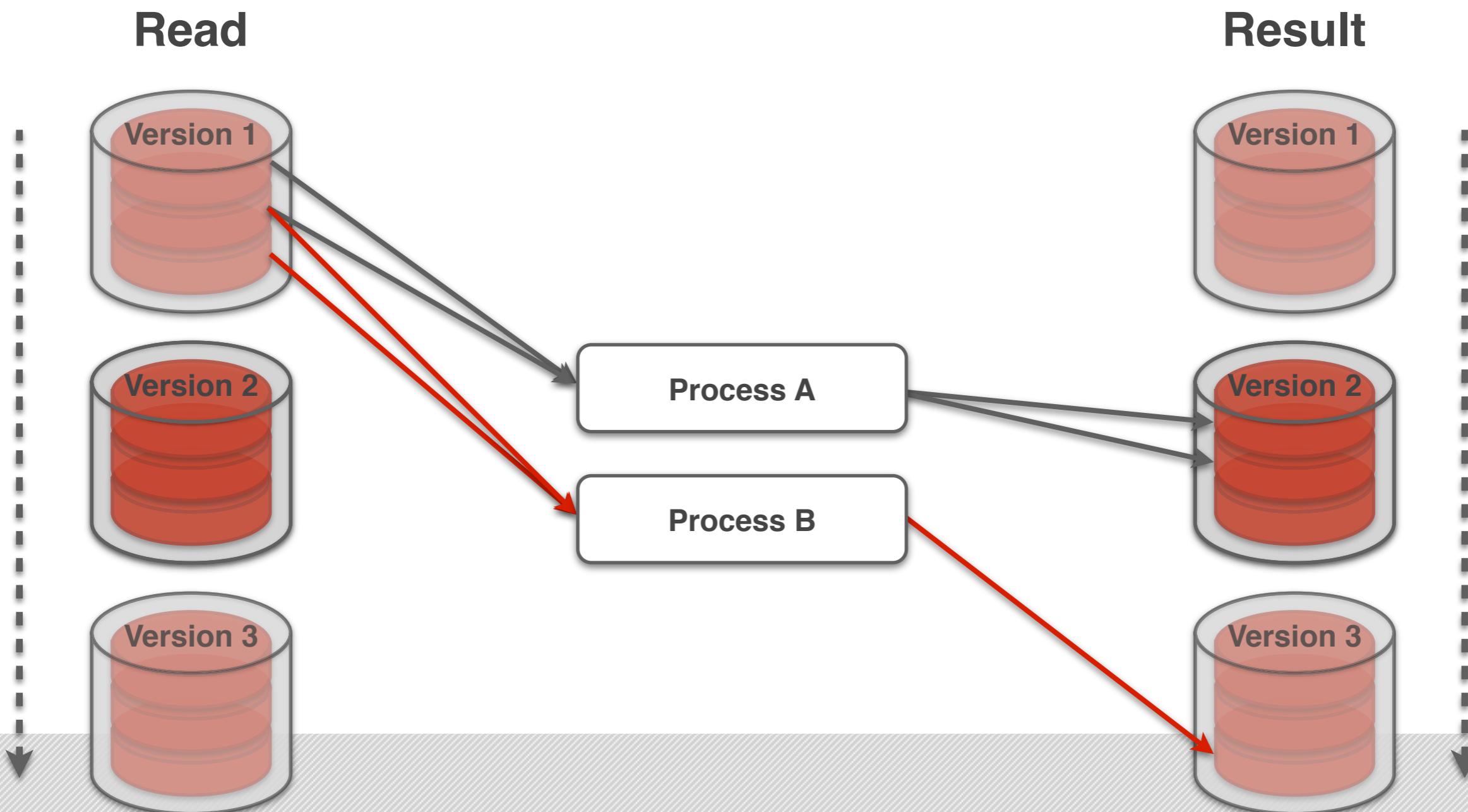


# Automated conflict resolution



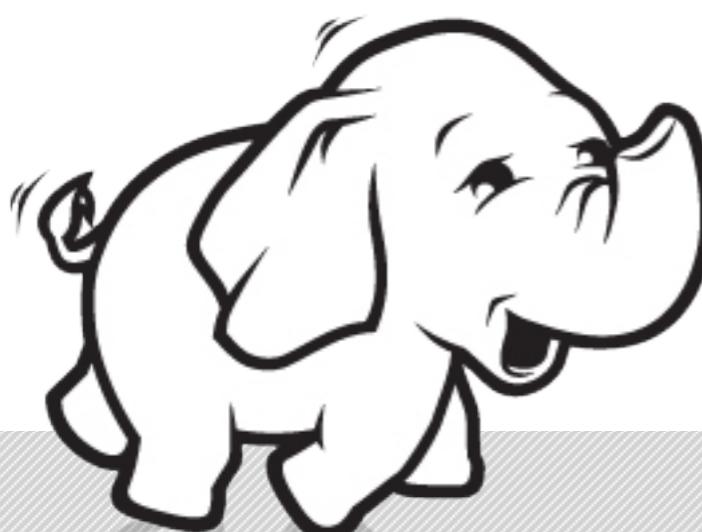
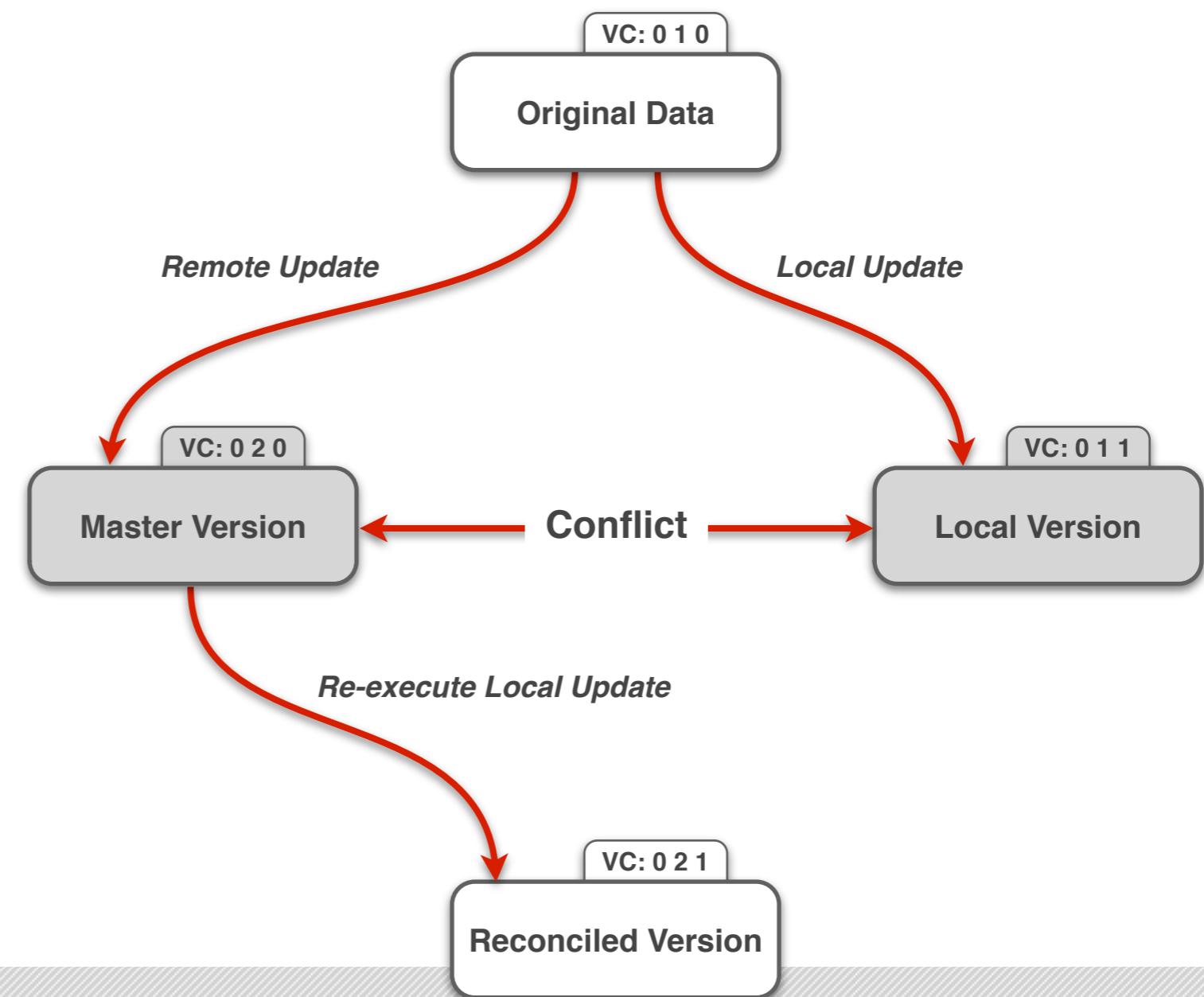


# Automated conflict resolution



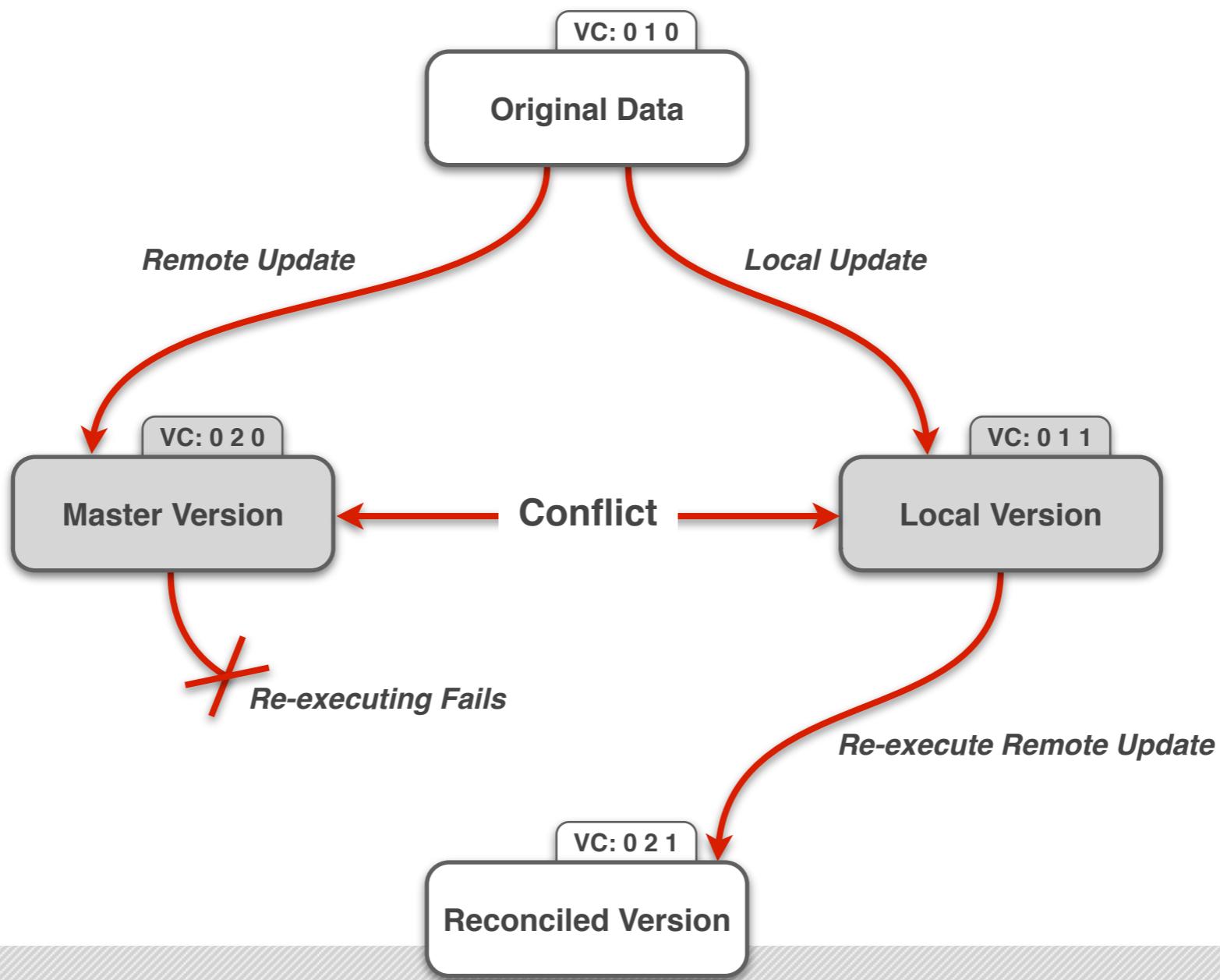


# Eager conflict resolution



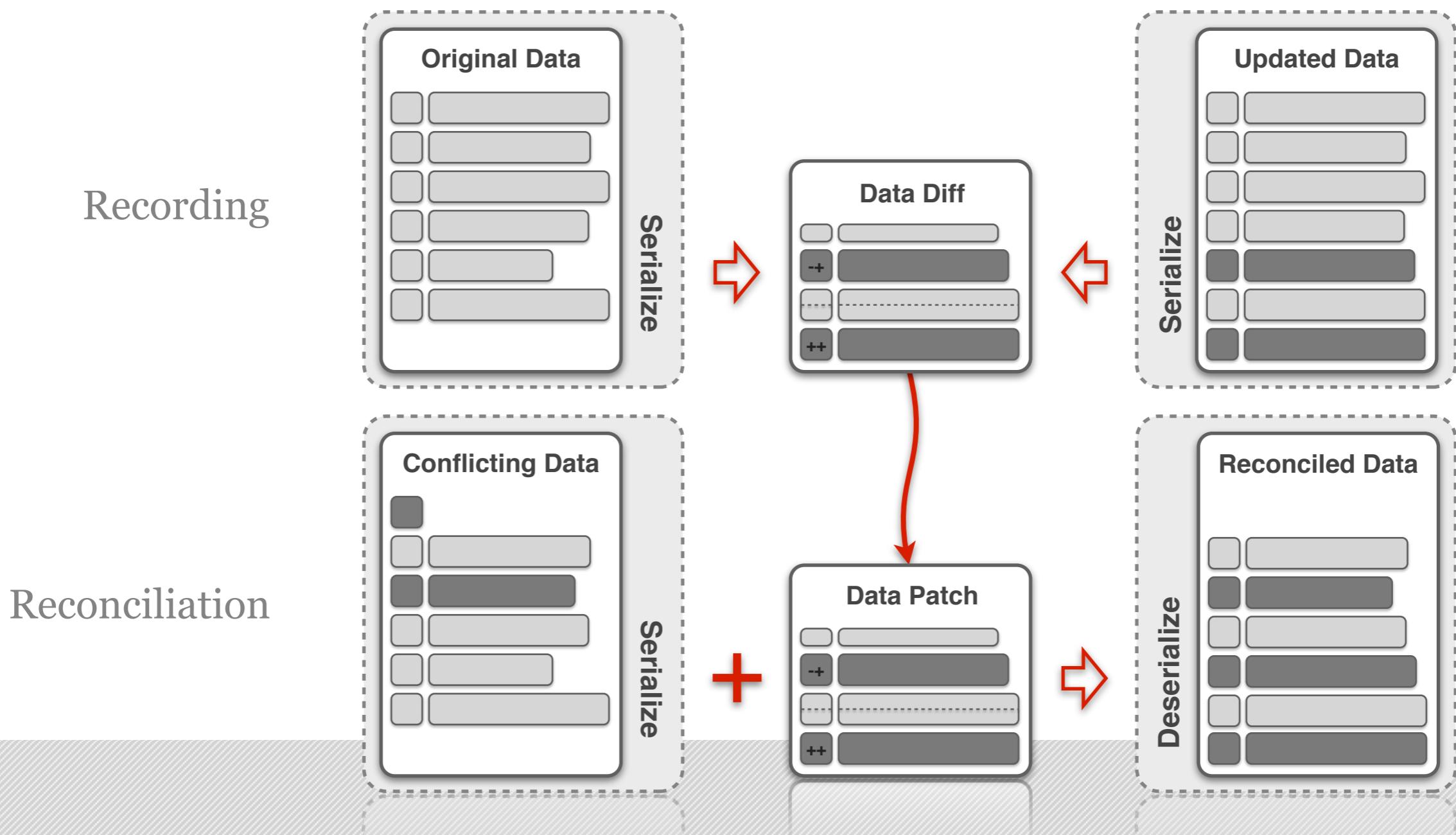


# Eager conflict resolution: reverse





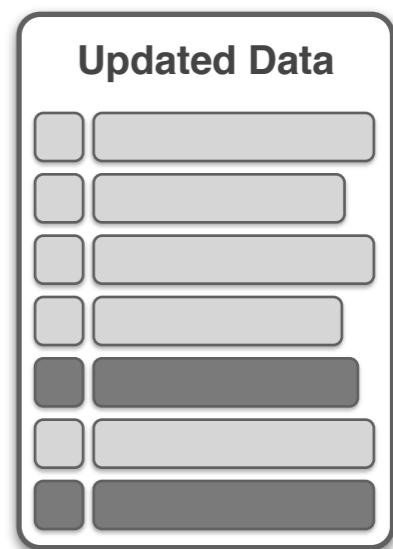
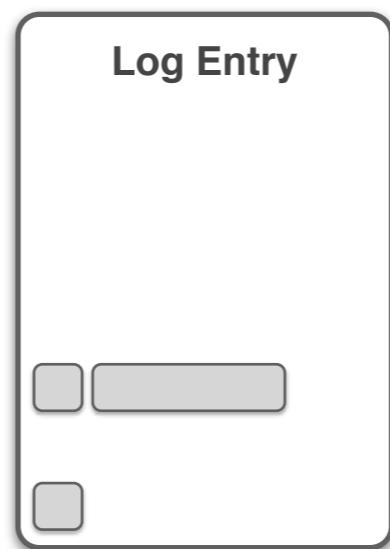
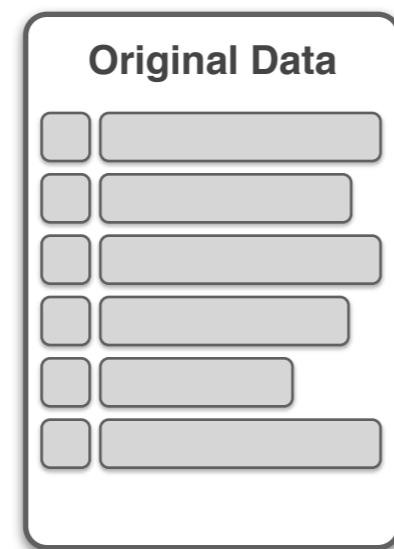
# Eager conflict resolution: serialized data





# Eager conflict resolution: attribute oriented

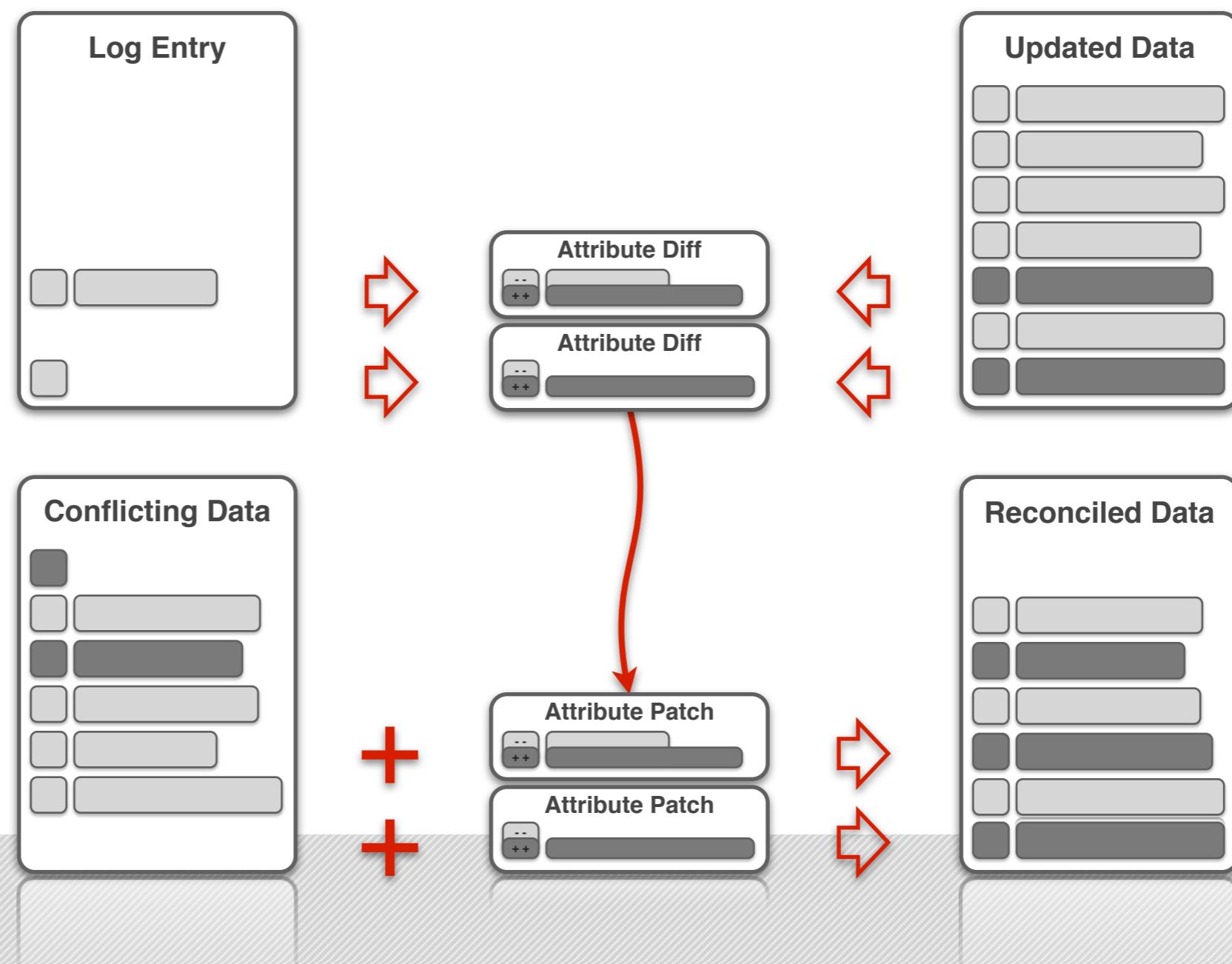
Recording





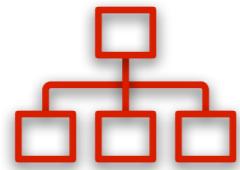
# Eager conflict resolution: attribute oriented

Reconciliation

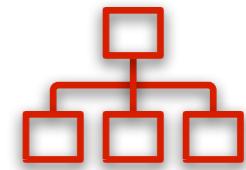




# Results



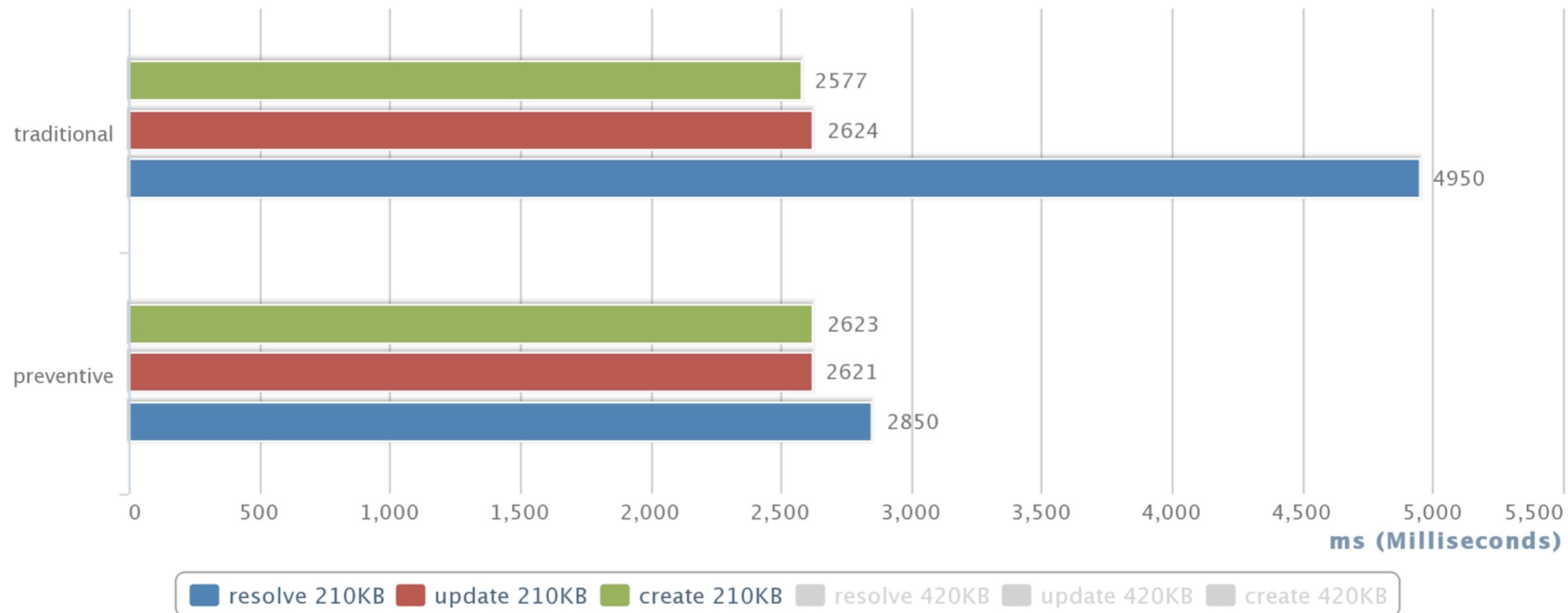
Network load

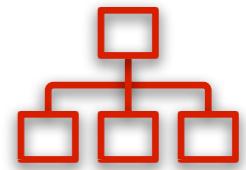


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### Traditional Synchronization vs. Preventive Reconciliation

Network load during different synchronization operations [Final Mean]

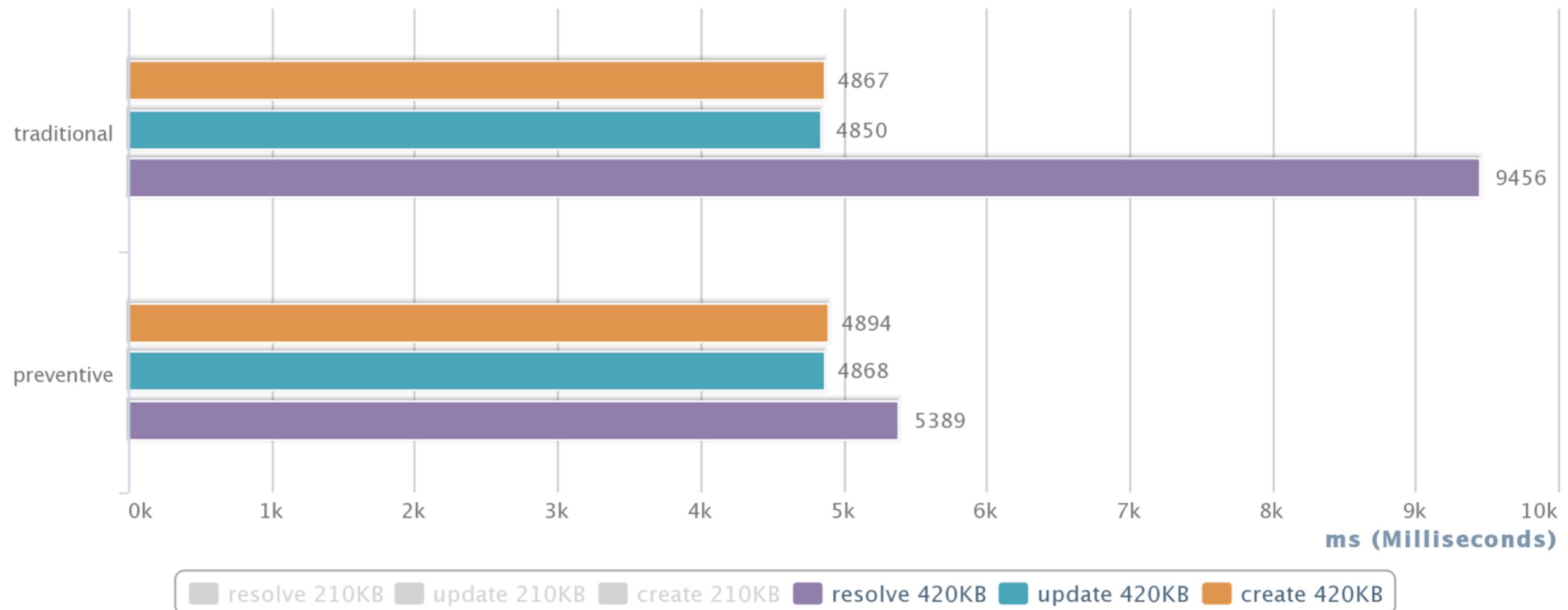




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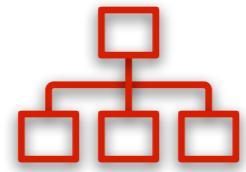
## Traditional Synchronization vs. Preventive Reconciliation

Network load during different synchronization operations [Final Mean]

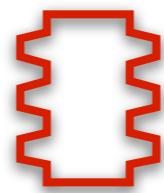




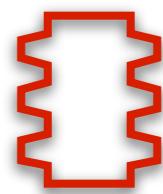
# Results



Network load

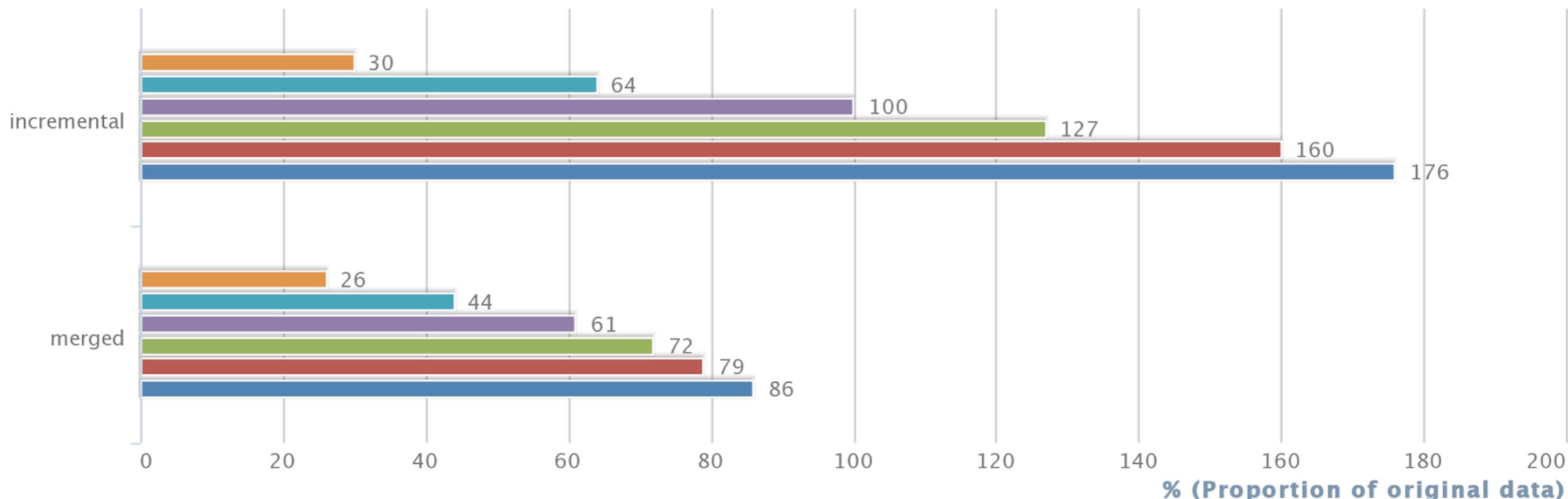


Memory footprint

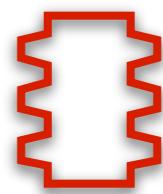


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Incremental vs. Merged Browser Log  
Memory footprint for recording local updates [Final Mean]

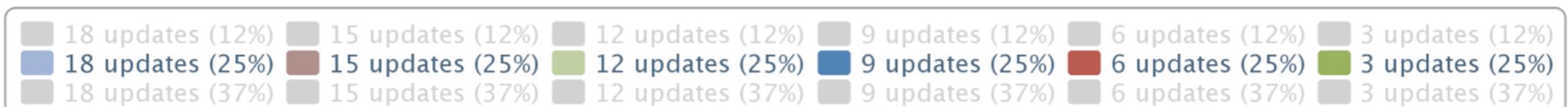
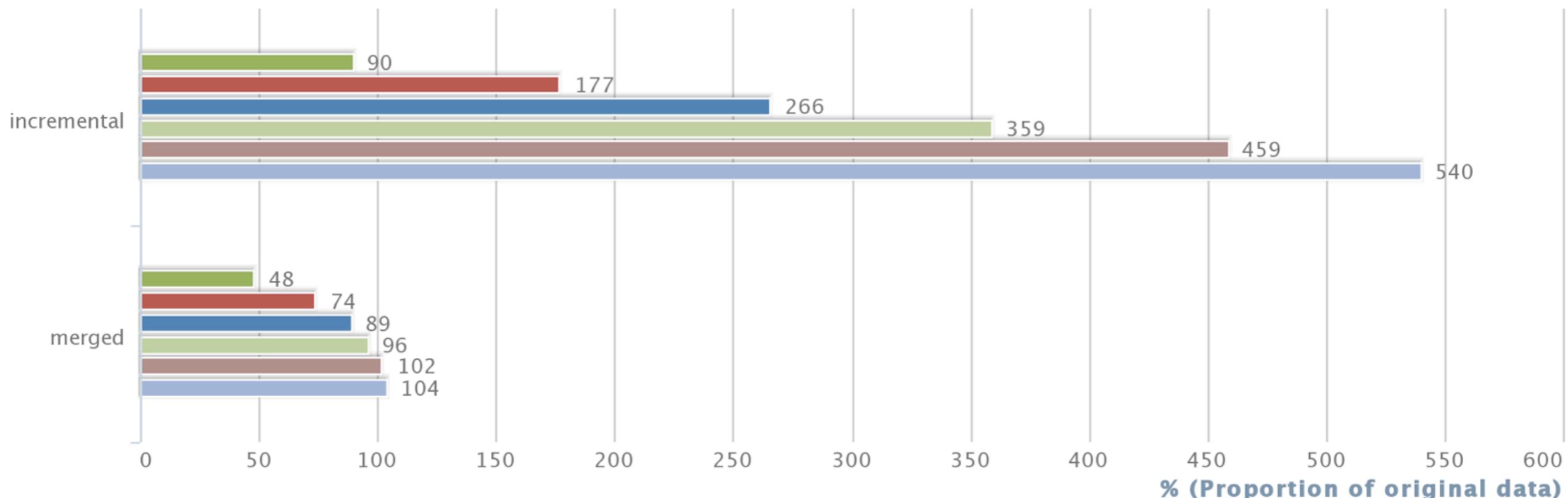


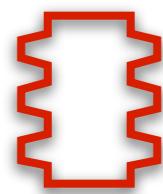
18 updates (12%)	15 updates (12%)	12 updates (12%)	9 updates (12%)	6 updates (12%)	3 updates (12%)
18 updates (25%)	15 updates (25%)	12 updates (25%)	9 updates (25%)	6 updates (25%)	3 updates (25%)
18 updates (37%)	15 updates (37%)	12 updates (37%)	9 updates (37%)	6 updates (37%)	3 updates (37%)



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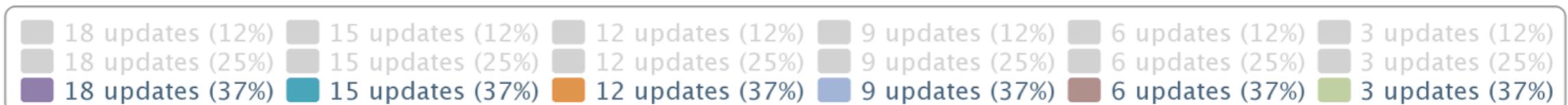
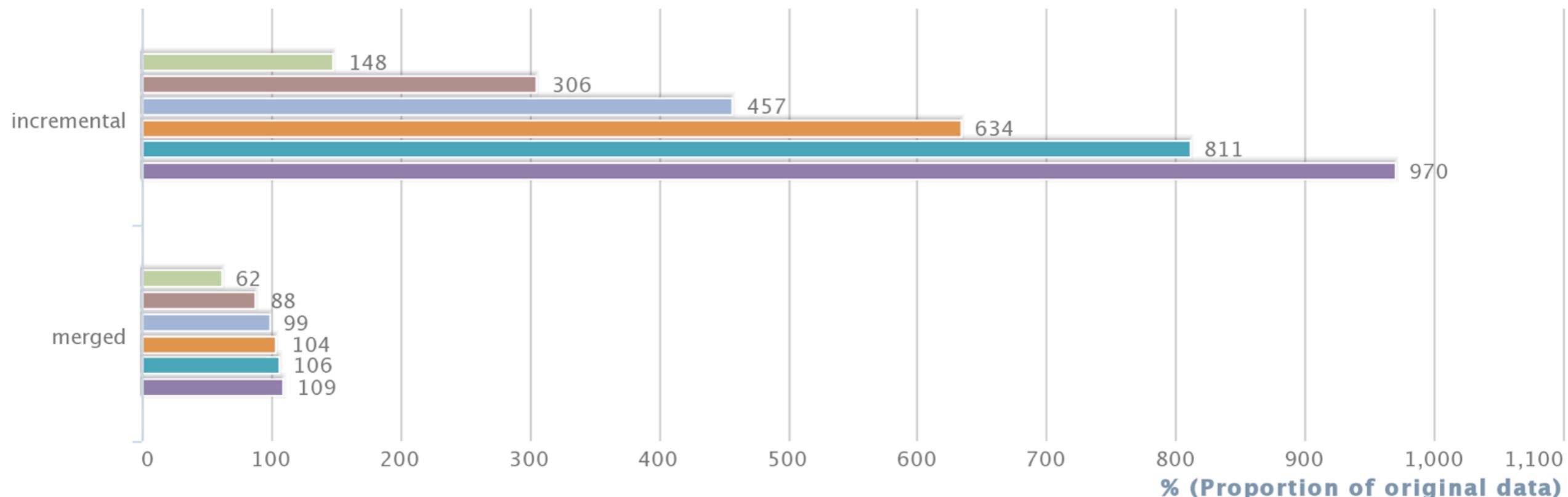
Incremental vs. Merged Browser Log  
Memory footprint for recording local updates [Final Mean]





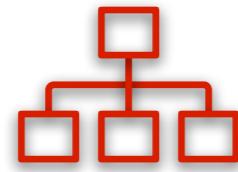
30-05-2013 |

Incremental vs. Merged Browser Log  
Memory footprint for recording local updates [Final Mean]

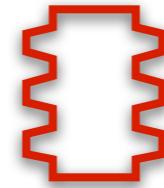




# Results



Network load



Memory footprint



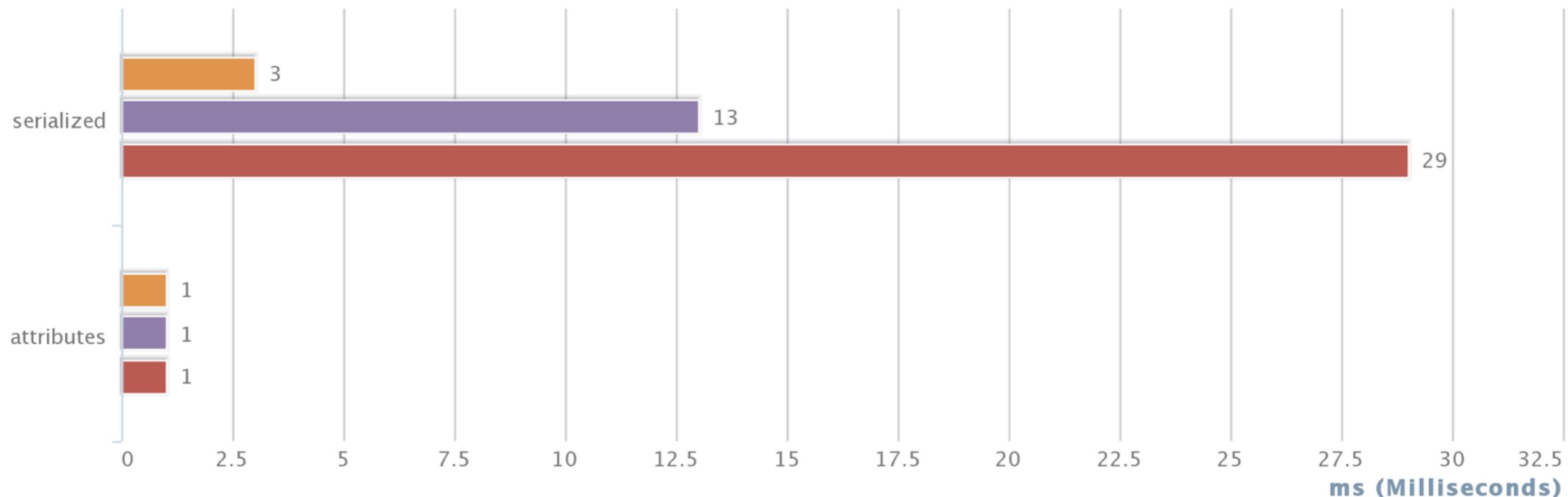
Conflict resolution

► Performance



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**Serialized Data vs. Attribute Oriented Approach**  
Performance overhead of recording updates and resolving conflicts [Final Mean]

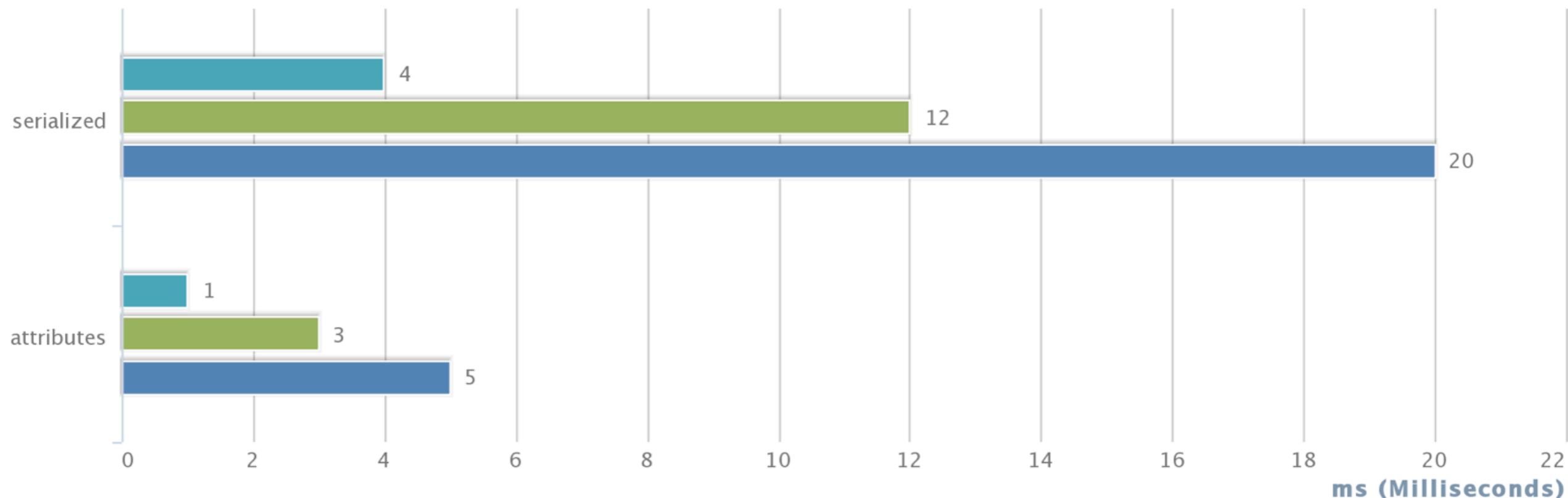


Legend:  
resolve(37%) record(37%) resolve(25%) record(25%) resolve(12%) record(12%)  
resolve 37% (strings & mods only) record 37% (strings & mods only)  
resolve 25% (strings & mods only) record 25% (strings & mods only)  
resolve 12% (strings & mods only) record 12% (strings & mods only)



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**Serialized Data vs. Attribute Oriented Approach**  
Performance overhead of recording updates and resolving conflicts [Final Mean]



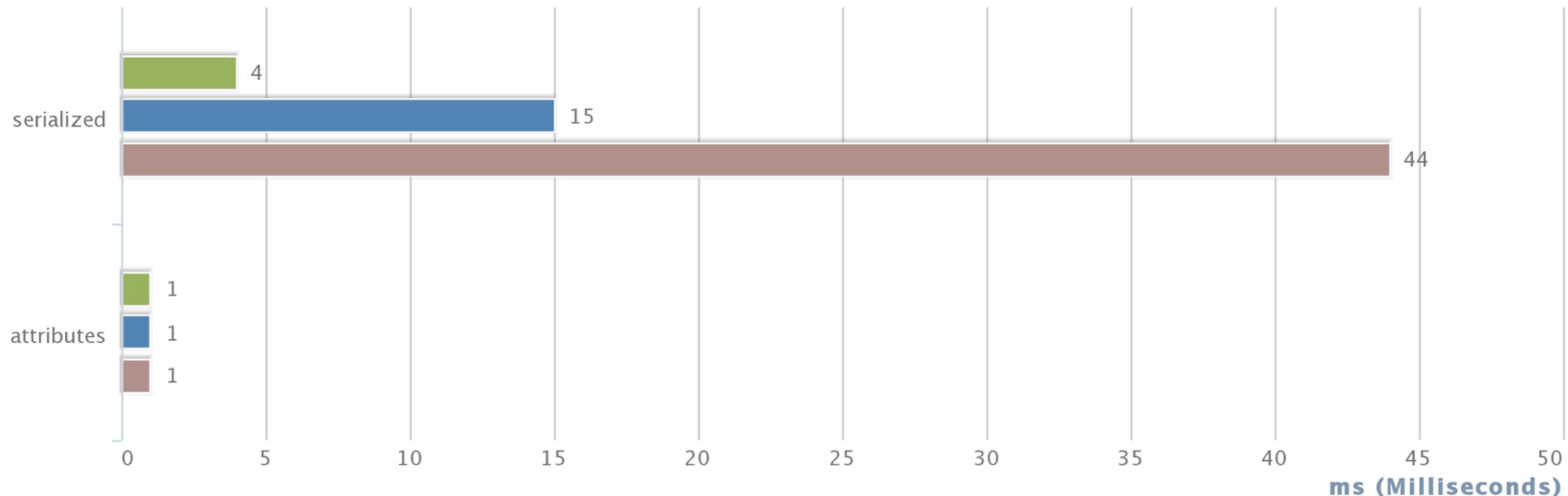
Legend:

- resolve(37%)
- record(37%)
- resolve(25%)
- record(25%)
- resolve(12%)
- record(12%)
- resolve 37% (strings & mods only)
- record 37% (strings & mods only)
- resolve 25% (strings & mods only)
- record 25% (strings & mods only)
- resolve 12% (strings & mods only)
- record 12% (strings & mods only)



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**Serialized Data vs. Attribute Oriented Approach**  
Performance overhead of recording updates and resolving conflicts [Final Mean]



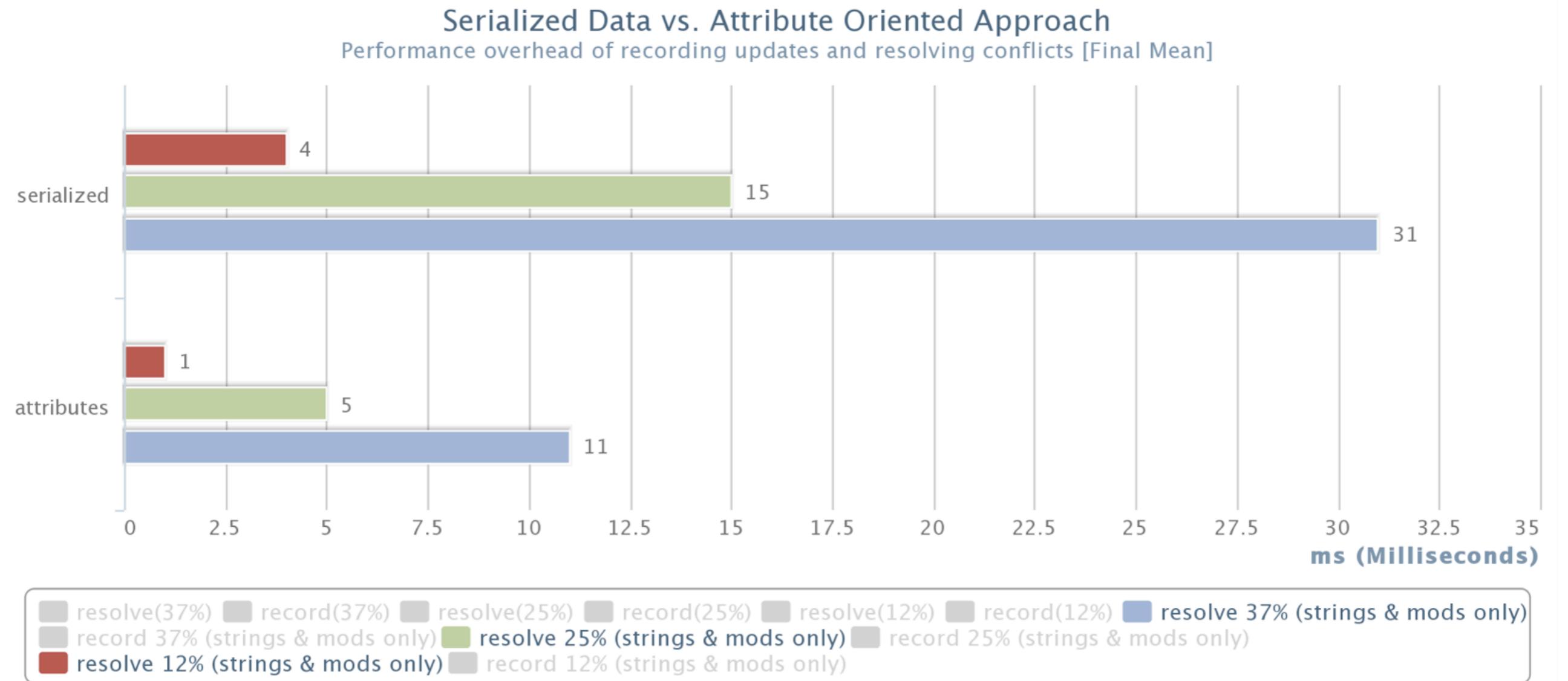
Legend:

- resolve(37%)
- record(37%)
- resolve(25%)
- record(25%)
- resolve(12%)
- record(12%)
- resolve 37% (strings & mods only)
- record 37% (strings & mods only)
- resolve 25% (strings & mods only)
- record 25% (strings & mods only)
- resolve 12% (strings & mods only)
- record 12% (strings & mods only)



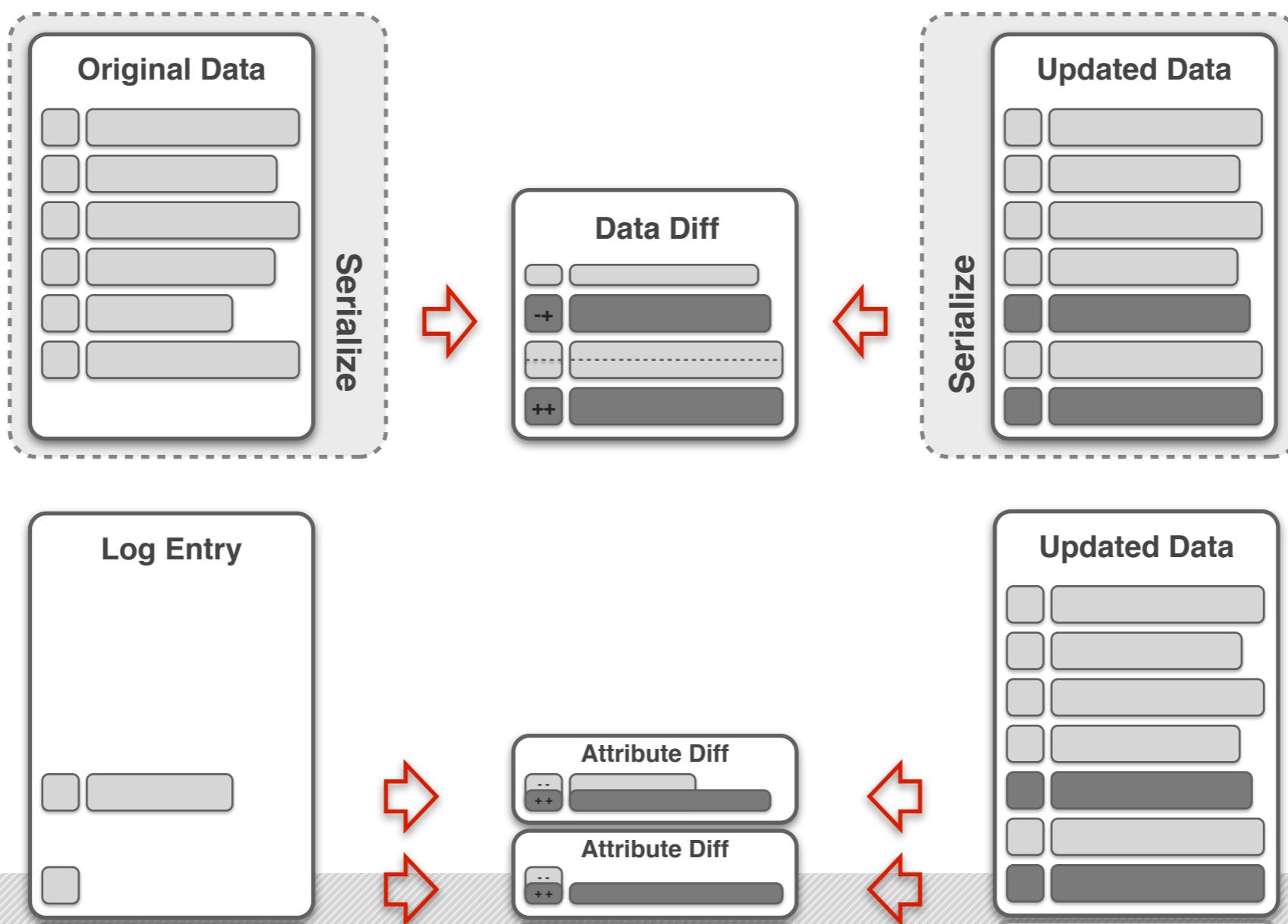
30-05-2013 |

6



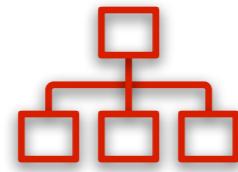


Time complexity:  $O(N + D^2)$

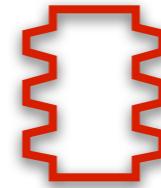




# Results



Network load



Memory footprint

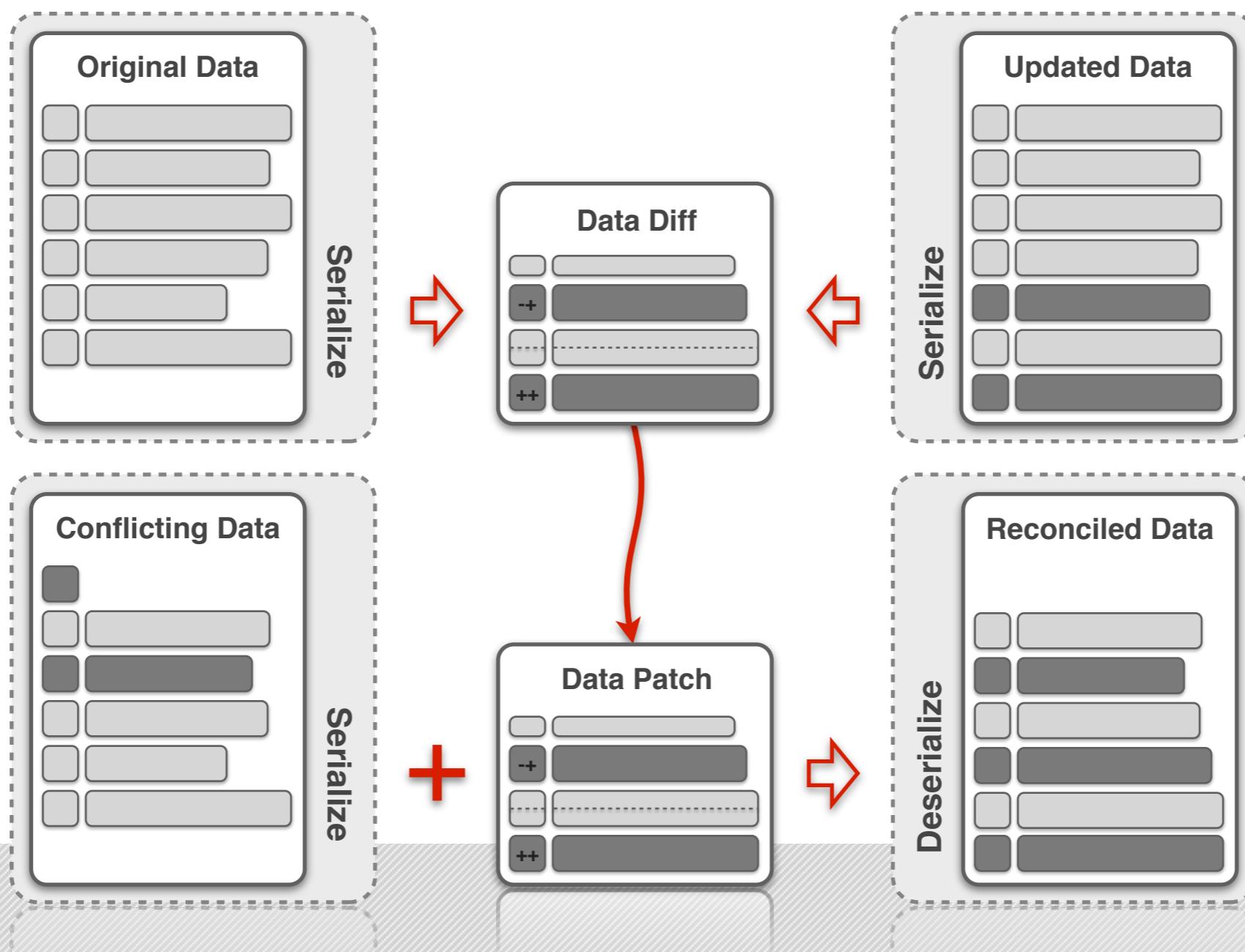


Conflict resolution

- ▶ Performance
- ▶ Resolution rate



# Conflict resolution rate

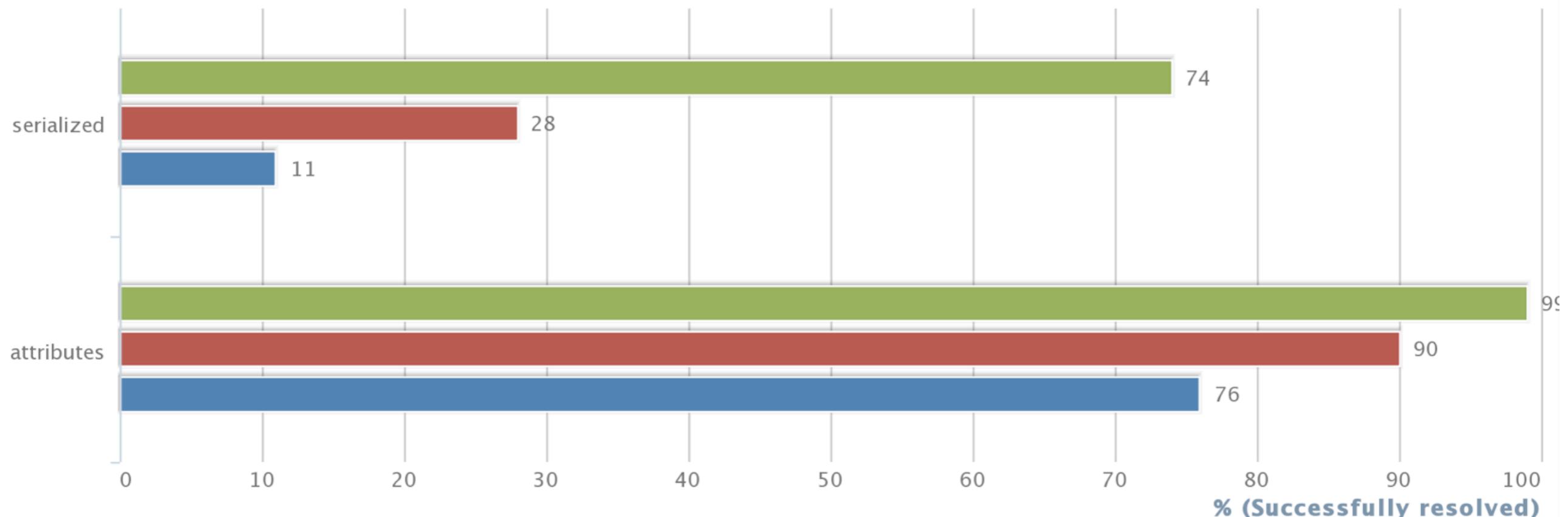




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### Serialized Data vs. Attribute Oriented Approach

Proportion successfully resolved conflicts [Final Mean]



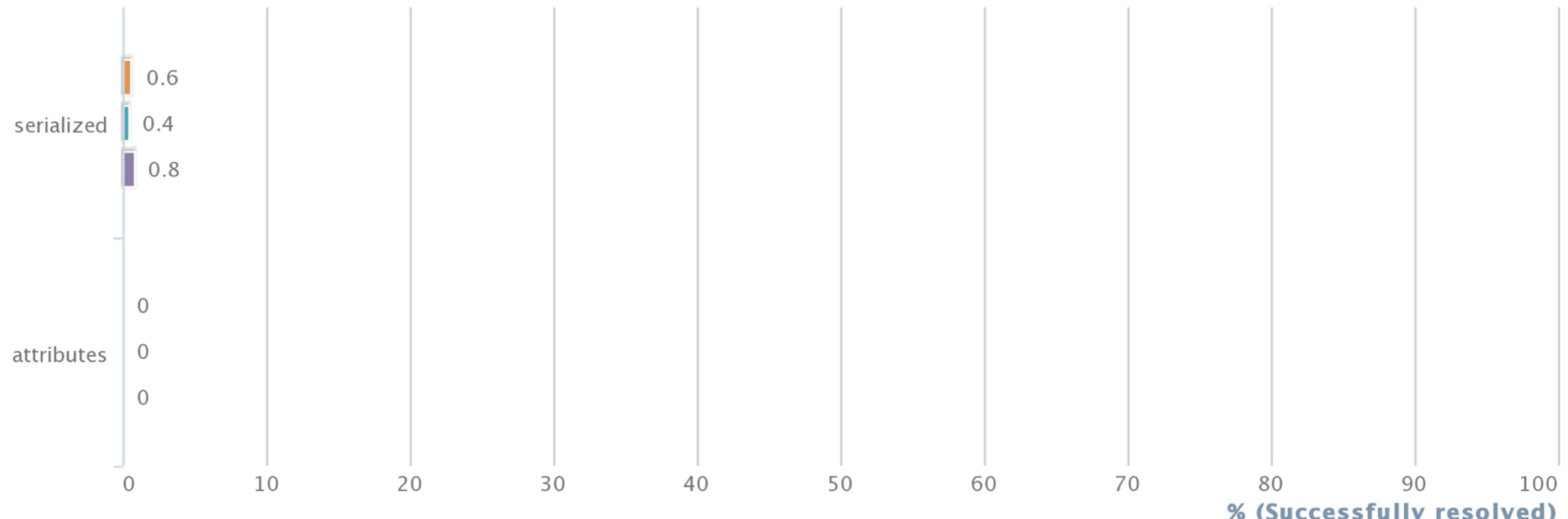
37% 25% 12% 37% (mangled data) 25% (mangled data) 12% (mangled data) 37% (strings only)  
25% (strings only) 12% (strings only) 37% (mods only) 25% (mods only) 12% (mods only)



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## Serialized Data vs. Attribute Oriented Approach

Proportion successfully resolved conflicts [Final Mean]



Legend:

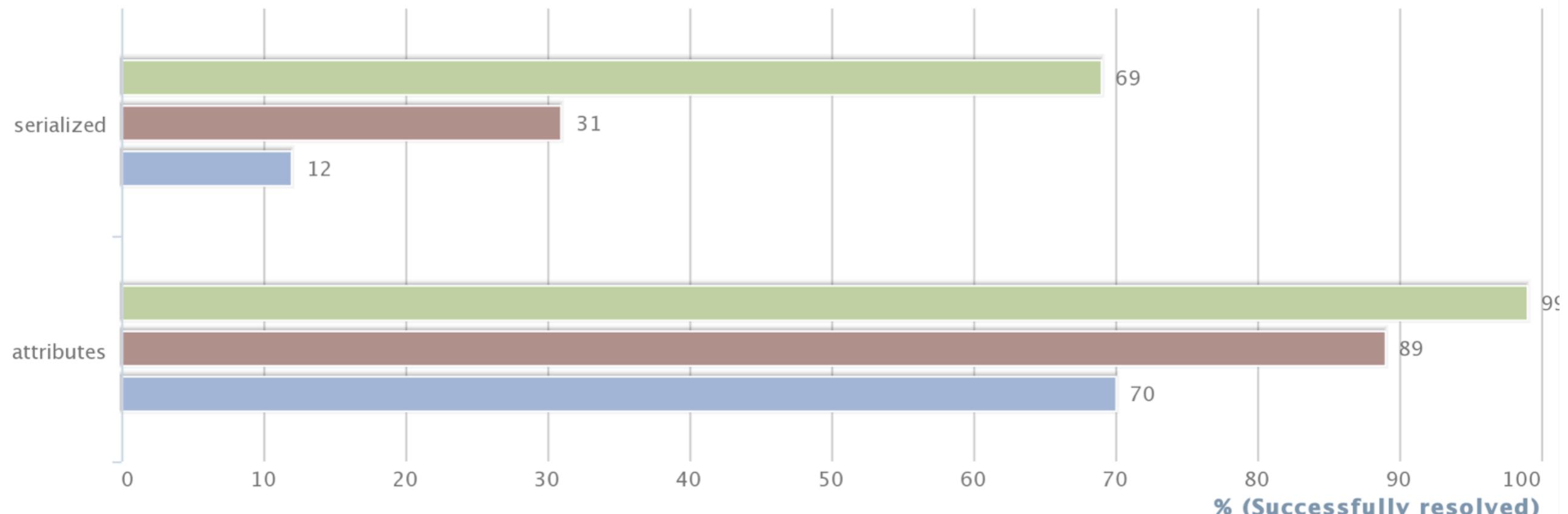
- 37% (mangled data)
- 25% (mangled data)
- 12% (mangled data)
- 37% (strings only)
- 25% (strings only)
- 12% (strings only)
- 37% (mods only)
- 25% (mods only)
- 12% (mods only)



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### Serialized Data vs. Attribute Oriented Approach

Proportion successfully resolved conflicts [Final Mean]



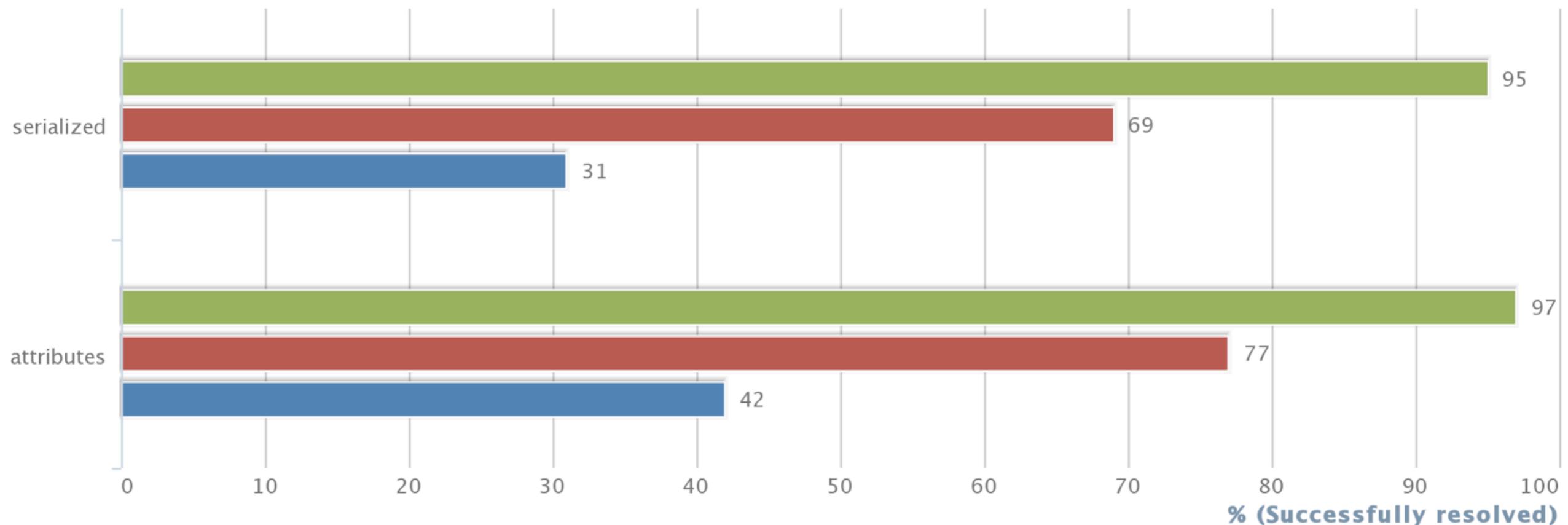
37% 25% 12% 37% (mangled data) 25% (mangled data) 12% (mangled data) 37% (strings only)  
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### Serialized Data vs. Attribute Oriented Approach

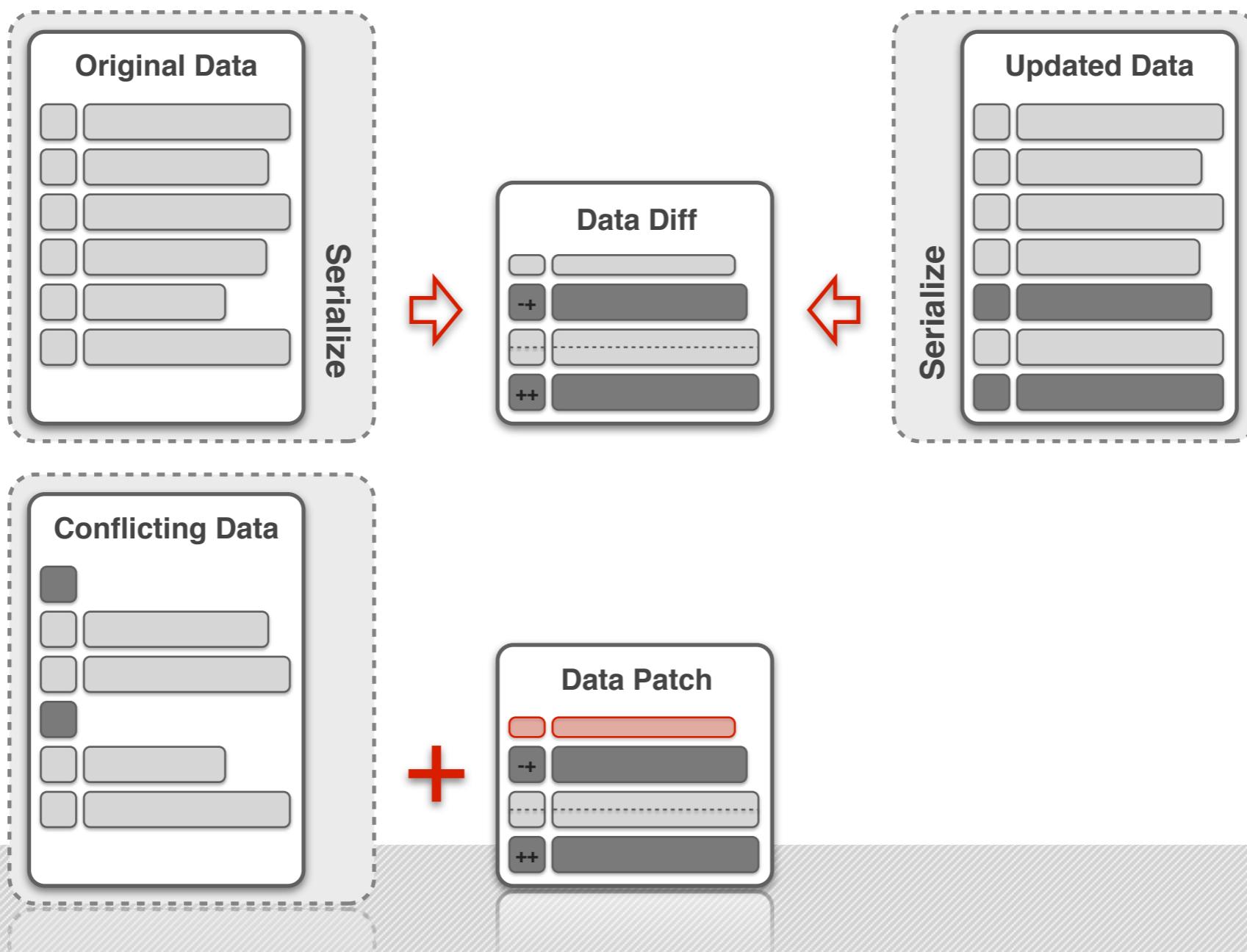
Proportion successfully resolved conflicts [Final Mean]



37% 25% 12% 37% (mangled data) 25% (mangled data) 12% (mangled data) 37% (strings only)  
25% (strings only) 12% (strings only) 37% (mods only) 25% (mods only) 12% (mods only)

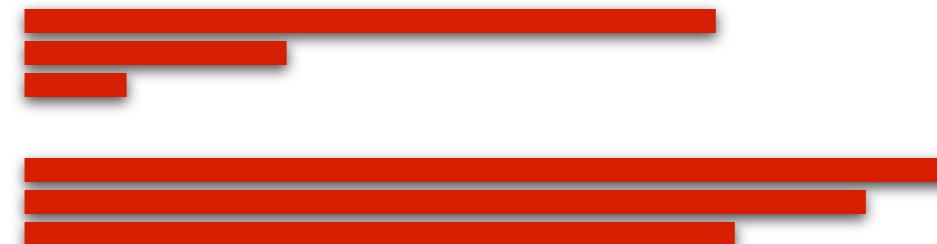
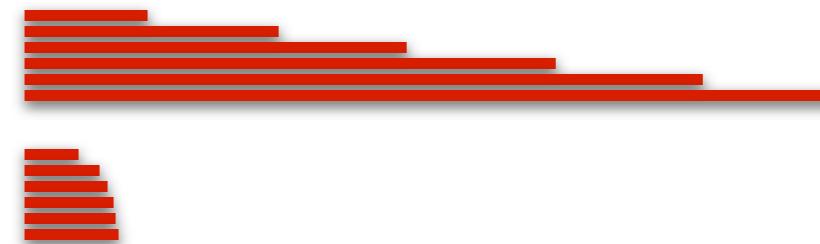
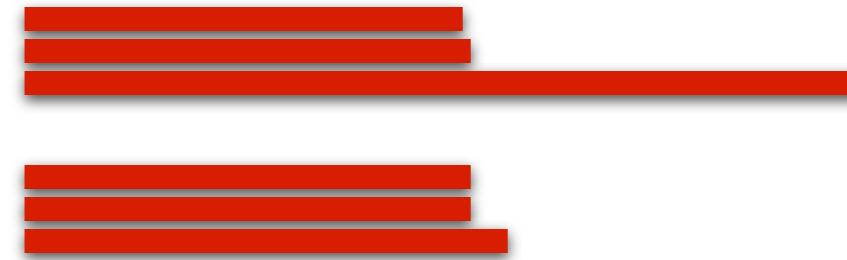
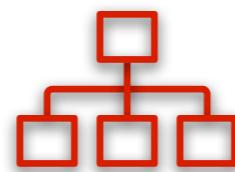


# Context mismatches





# Conclusion





university of  
groningen

faculty of mathematics  
and natural sciences

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# Questions?

› [Github.com/krikis/nomad](https://github.com/krikis/nomad)