Berner Fachhochschule
Technik und Informatik

Secure Distributed Bulletin Board

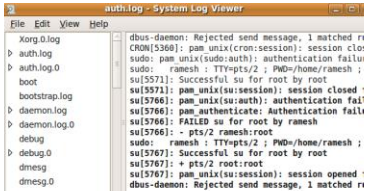
Beuchat José, 26.01.2012

What Is a Bulletin Board?

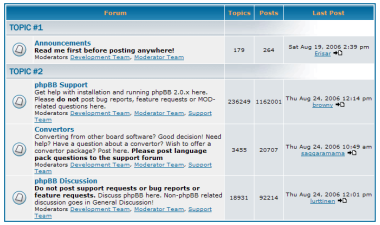
- Computer system
- Share messages
- Append only
- Public (for reading)
- Can be on the Internet

Typical Applications

- E-voting
- Auctions
- Online Petitions
- Auditable Discussion Boards
- System Logs



```
dbus-daemon: Rejected send message, 1 matched r
CRON[5360]: pam_unix(cron:session): session clo
sudo: pam_unix(sudo:auth): authentication failu
sudo:   ramesh : TTY=pts/2 ; PWD=/home/ramesh ;
su[5571]: Successful su for root by root
su[5571]: pam_unix(su:session): session closed
su[5766]: pam_unix(su:auth): authentication fai
su[5766]: pam_authenticate: Authentication fail
su[5766]: FAILED su for root by ramesh
su[5766]: - pts/2 ramesh:root
sudo:   ramesh : TTY=pts/2 ; PWD=/home/ramesh ;
su[5767]: Successful su for root by root
su[5767]: + pts/2 root:root
su[5767]: pam_unix(su:session): session opened
dbus-daemon: Rejected send message, 1 matched r
```



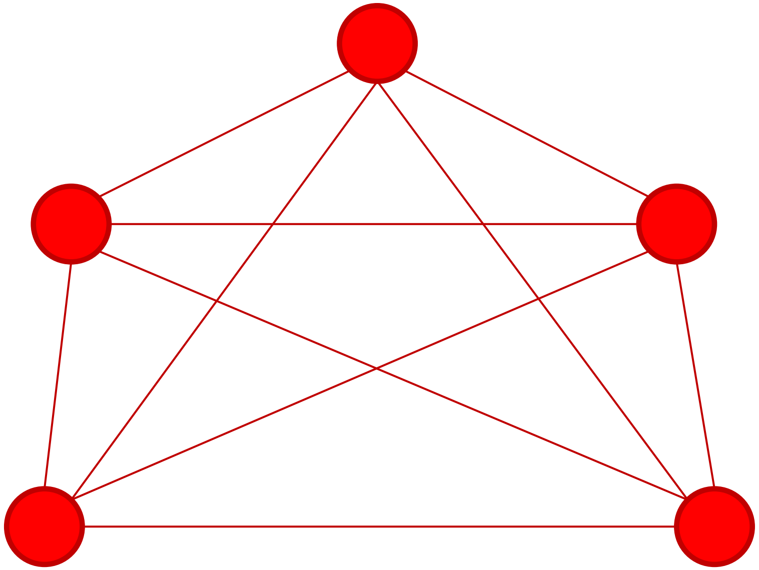
Forum	Topics	Posts	Last Post
TOPIC #1			
Announcements **Read me first before posting anywhere!** Moderators Development Team, Moderator Team	179	264	Sat Aug 19, 2006 2:39 pm Erisar
TOPIC #2			
phpBB Support Get help with installation and running phpBB 2.0.x here. Please **do not** post bug reports, feature requests or MOD-related questions here. Moderators Development Team, Moderator Team, Support Team	236249	1162001	Thu Aug 24, 2006 12:14 pm browny
Convertors Converting from other board software? Good decision! Need help? Have a question about a convertor? Wish to offer a convertor package? Post here. **Please post language pack questions to the support forum** Moderators Development Team, Moderator Team, Support Team	3455	20707	Thu Aug 24, 2006 10:49 am saggaramama
phpBB Discussion **Do not post support requests or bug reports or feature requests.** Discuss phpBB here. Non-phpBB related discussion goes in General Discussion! Moderators Development Team, Moderator Team, Support Team	18931	92214	Thu Aug 24, 2006 12:01 pm lurttinen

Requirements

- Availability
- Append only
- Failure detection
- No single point of failure

A Distributed Solution

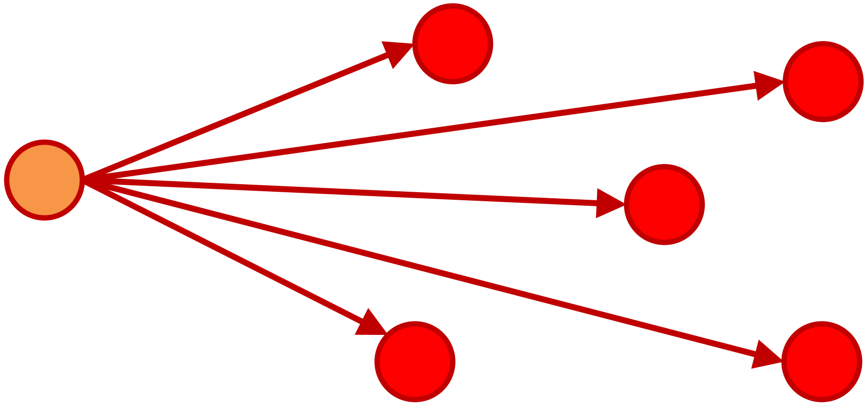
- Fully connected network with *n* parties.
- Replicated content.



Byzantine Generals Problem

- Using a secure broadcast channel ensures that every party receives the same message.

  – Condition: more than 2/3 of the parties must be correct.

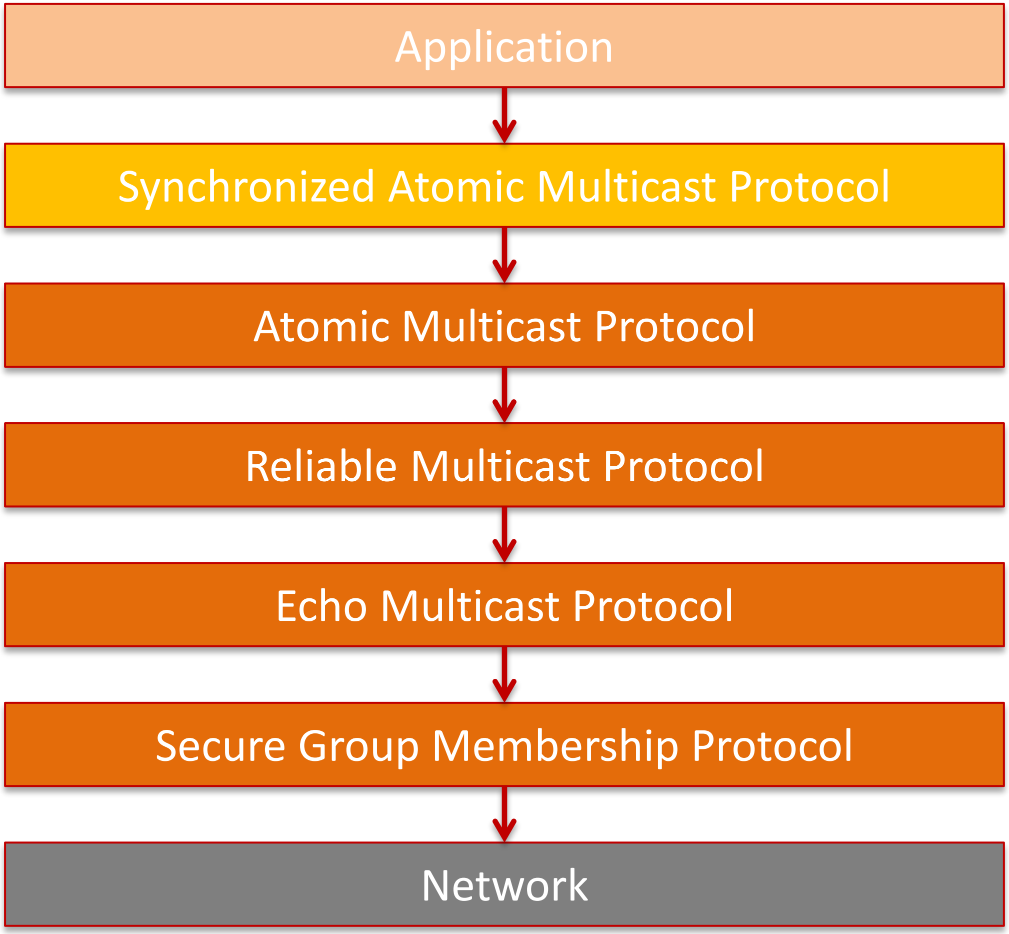


Rampart

“Rampart is a toolkit of protocols to facilitate the development of high-integrity services, i.e., ***distributed*** *services that retain their* ***availability*** *and* ***correctness*** *despite the malicious penetration of some component servers by an* ***attacker****.”*

(*Secure Agreement Protocols: Reliable and Atomic Group Multicast in Rampart* by Michael K. Reiter)

The Protocols Stack



Application

Synchronized Atomic Multicast Protocol

Atomic Multicast Protocol

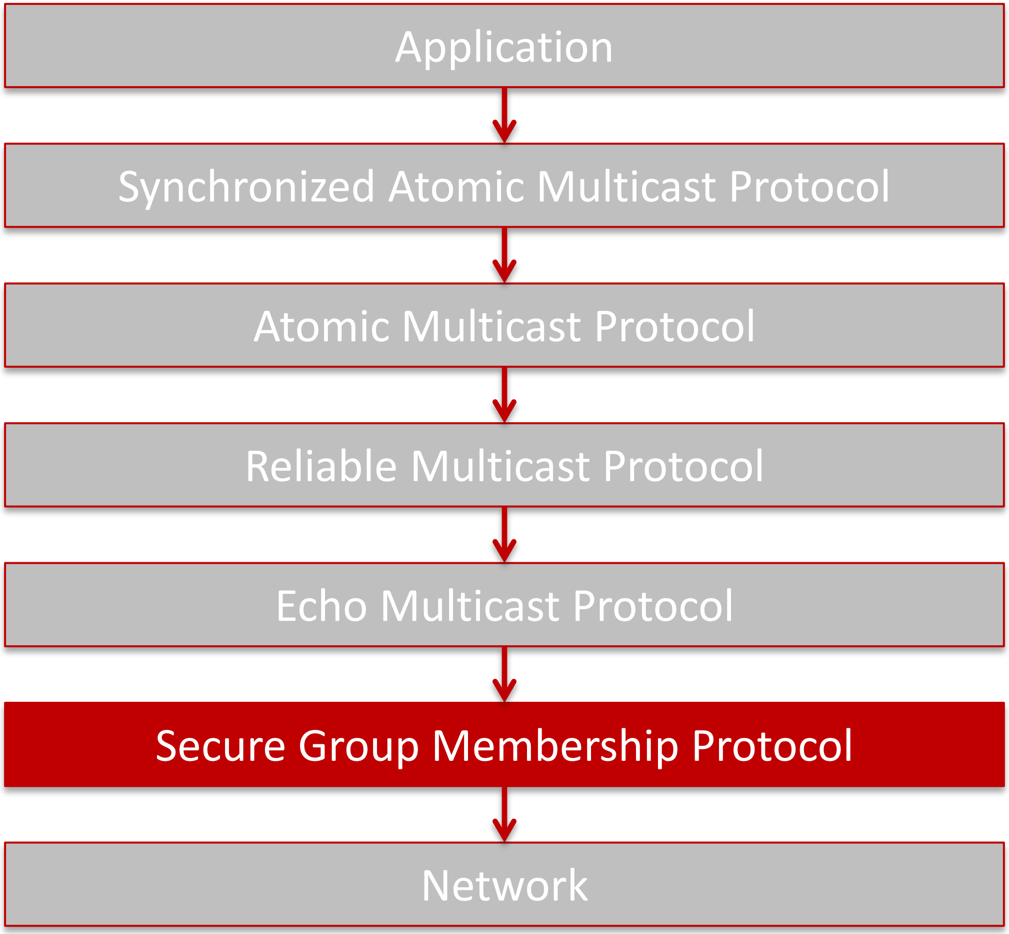
Reliable Multicast Protocol

Echo Multicast Protocol

Secure Group Membership Protocol

Network

Secure Group Membership Protocol



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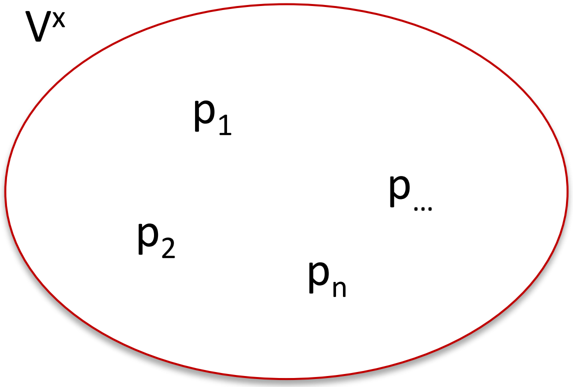
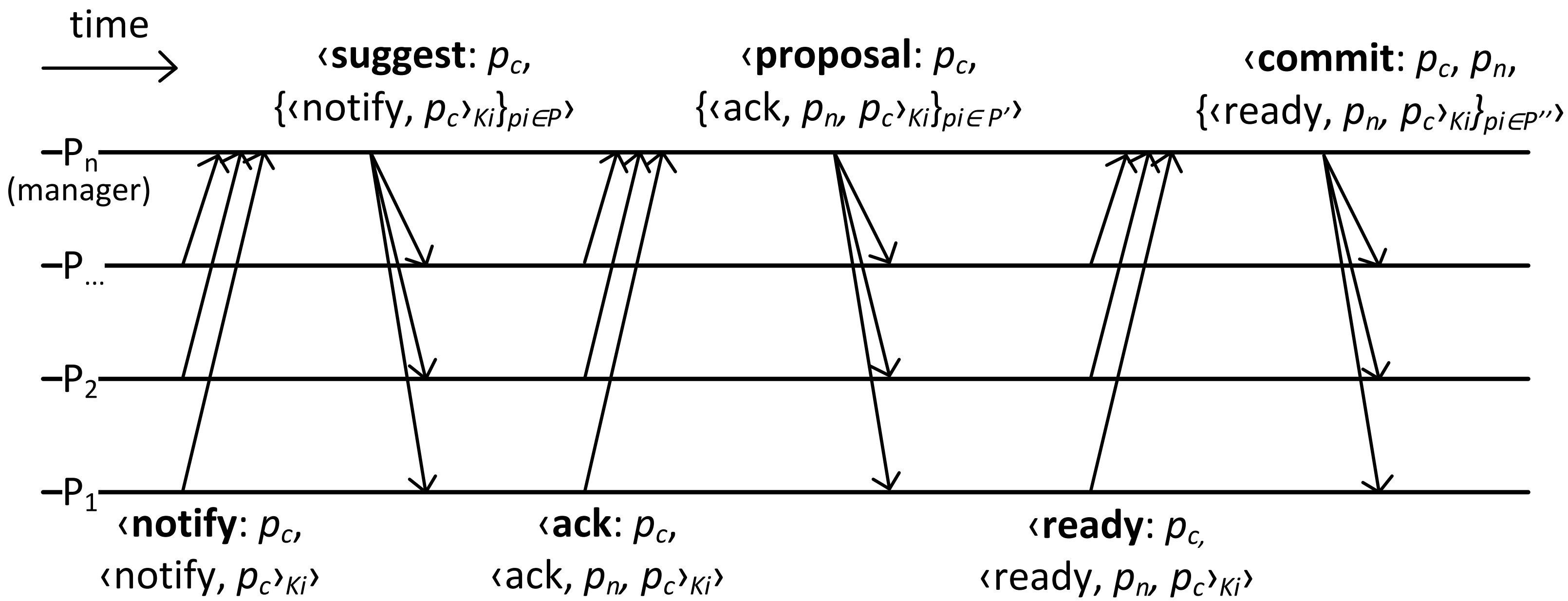
Secure Group Membership Protocol (1/2)

- Maintains a set of correct parties (the view *V*).
- Parties can be added or removed.
- Views are the same at each correct party.
- Parties are totally ordered (rank 1 to *n*).
- Party with rank *n* is the manager (p_m).



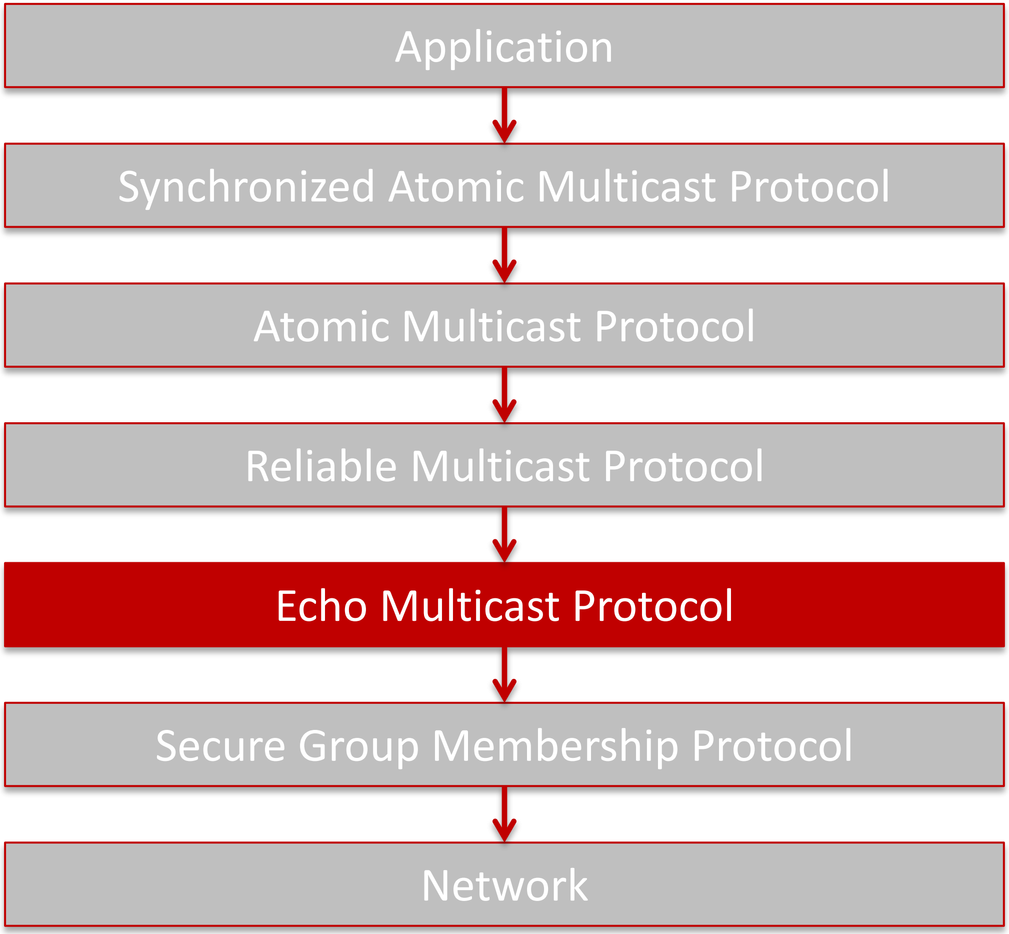
Secure Group Membership Protocol (2/2)

Remove or add a party p_c:



time
‹**suggest**: p_c,
$\{$‹notify, p_c›$_{Ki}\}_{pi \in P}$›
‹**proposal**: p_c,
$\{$‹ack, p_n, p_c›$_{Ki}\}_{pi \in P'}$›
‹**commit**: p_c, p_n,
$\{$‹ready, p_n, p_c›$_{Ki}\}_{pi \in P''}$›
P_n
(manager)
$P_{...}$
P_2
P_1
‹**notify**: p_c,
‹notify, p_c›$_{Ki}$›
‹**ack**: p_c,
‹ack, p_n, p_c›$_{Ki}$›
‹**ready**: p_c,
‹ready, p_n, p_c›$_{Ki}$›

Echo Multicast Protocol



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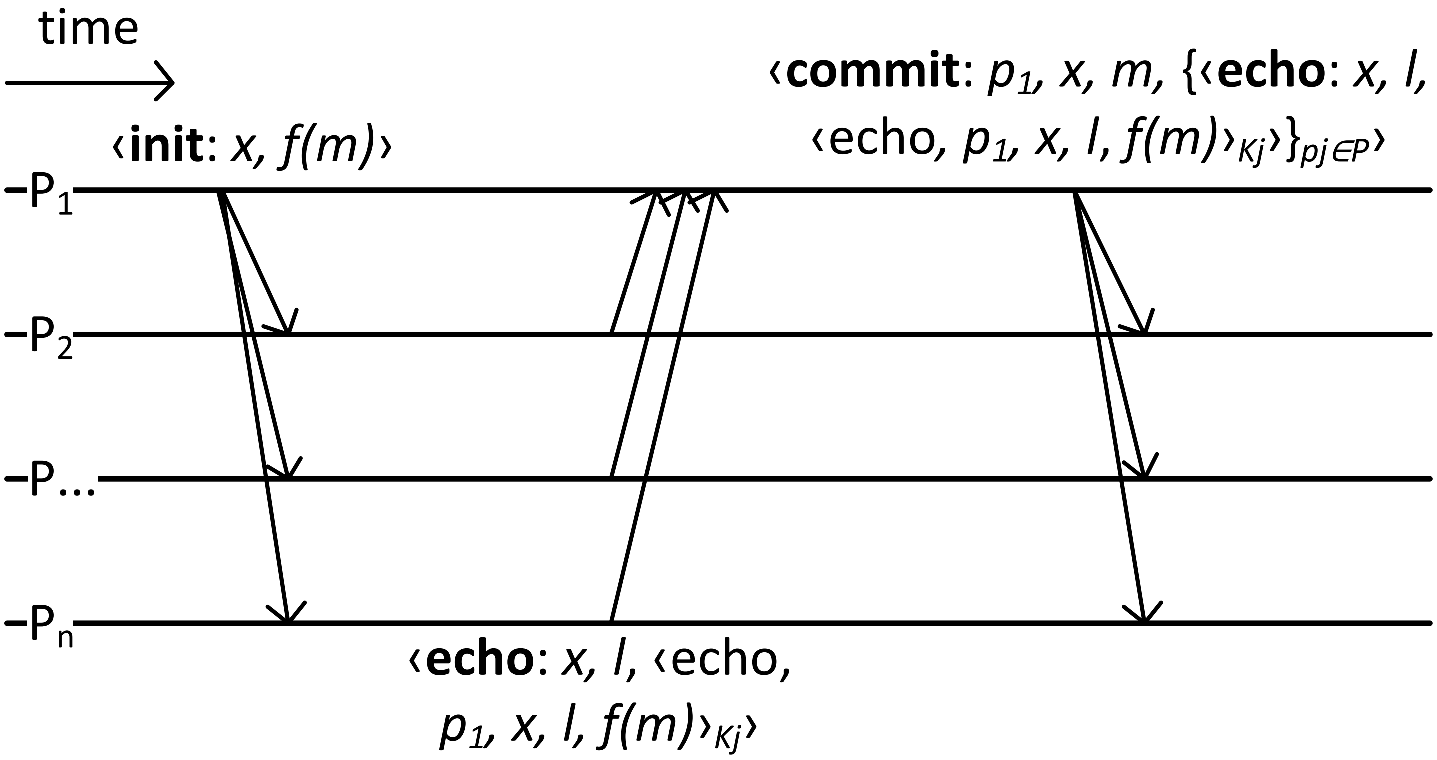
Echo Multicast Protocol (1/2)

- Ensures that each message sent by a party *p* in view *x* is the same at each correct party.
- Delivers messages to the upper layer once they are stable (received by every party).
- Each party periodically sends counters messages, indicating the messages it has received.

Echo Multicast Protocol (2/2)

Party p_1 multicast a message m in view x:



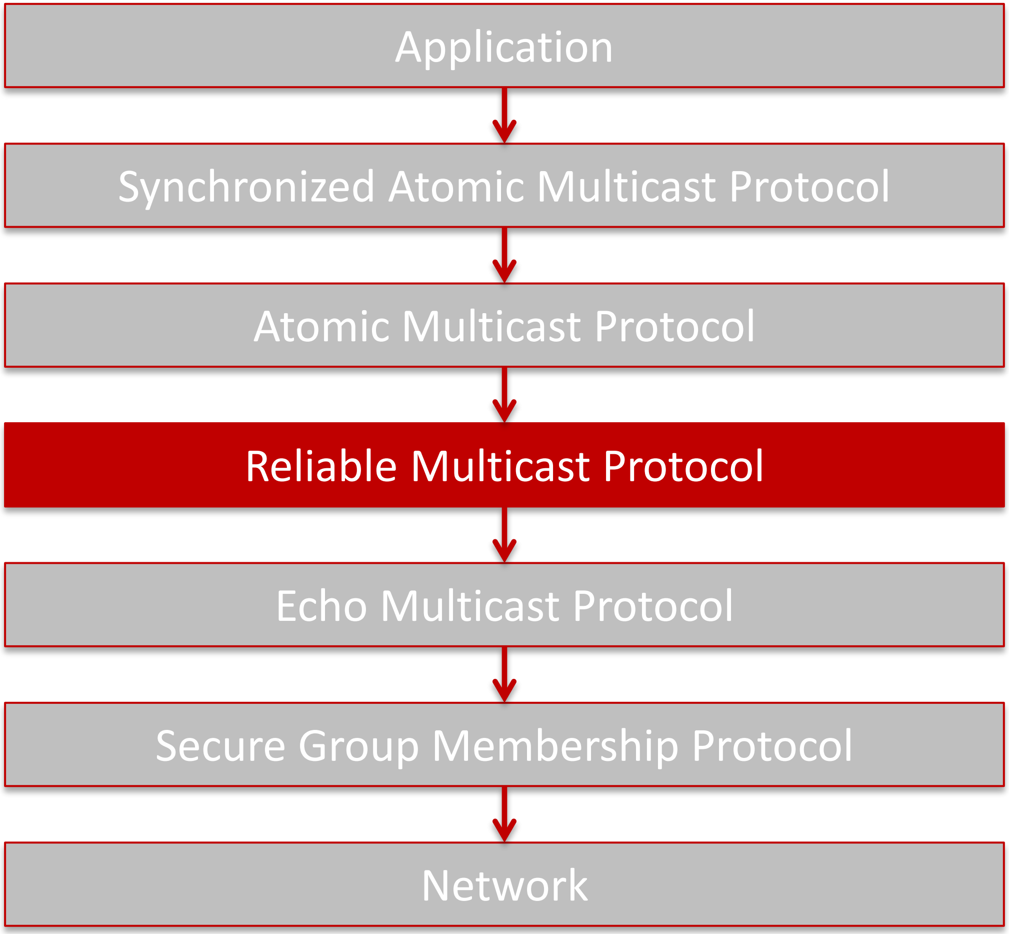
$\langle \textbf{init}: x, f(m) \rangle$

$\langle \textbf{echo}: x, l, \langle \text{echo}, p_1, x, l, f(m) \rangle_{K_j} \rangle$

$\langle \textbf{commit}: p_1, x, m, \{ \langle \textbf{echo}: x, l, \langle \text{echo}, p_1, x, l, f(m) \rangle_{K_j} \rangle \}_{p_j \in P} \rangle$

l: amount of messages received by a certain party in view x

Reliable Multicast Protocol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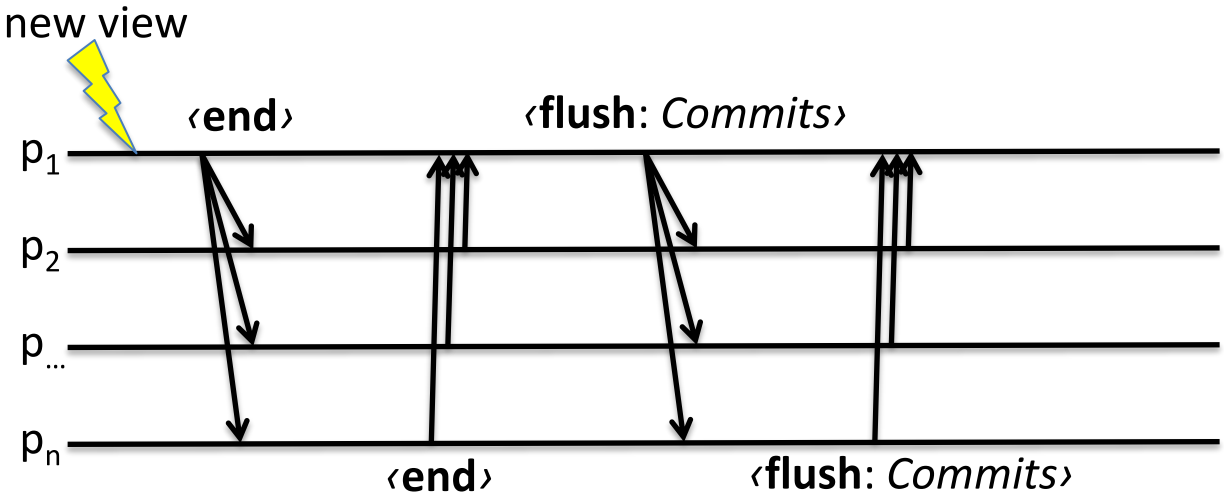
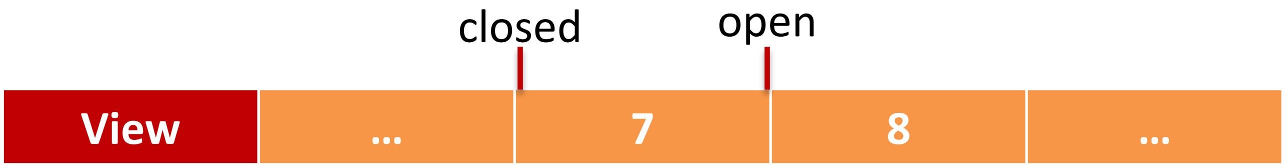
Reliable Multicast Protocol (1/2)

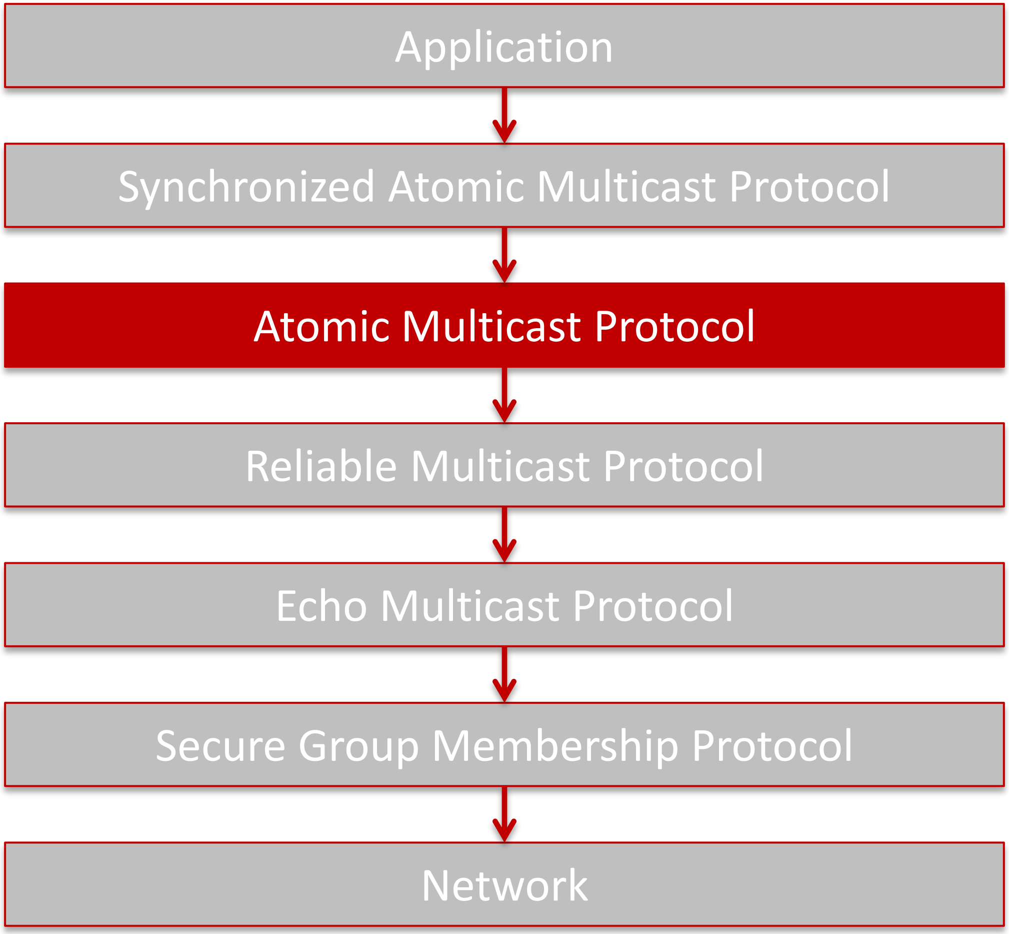
- Uses the Echo Multicast Protocol.
- Makes messages stable if a new view is created.
- Refuses messages for closed views.
- Buffers messages for future views.

Reliable Multicast Protocol (2/2)





Atomic Multicast Protocol



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Atomic Multicast Protocol (1/2)

- Uses the Reliable Multicast Protocol.
- Ensures that correct parties deliver messages in the same order.
- Each view has a sequencer, which periodically multicast the order in which it received the messages.

Atomic Multicast Protocol (2/2)

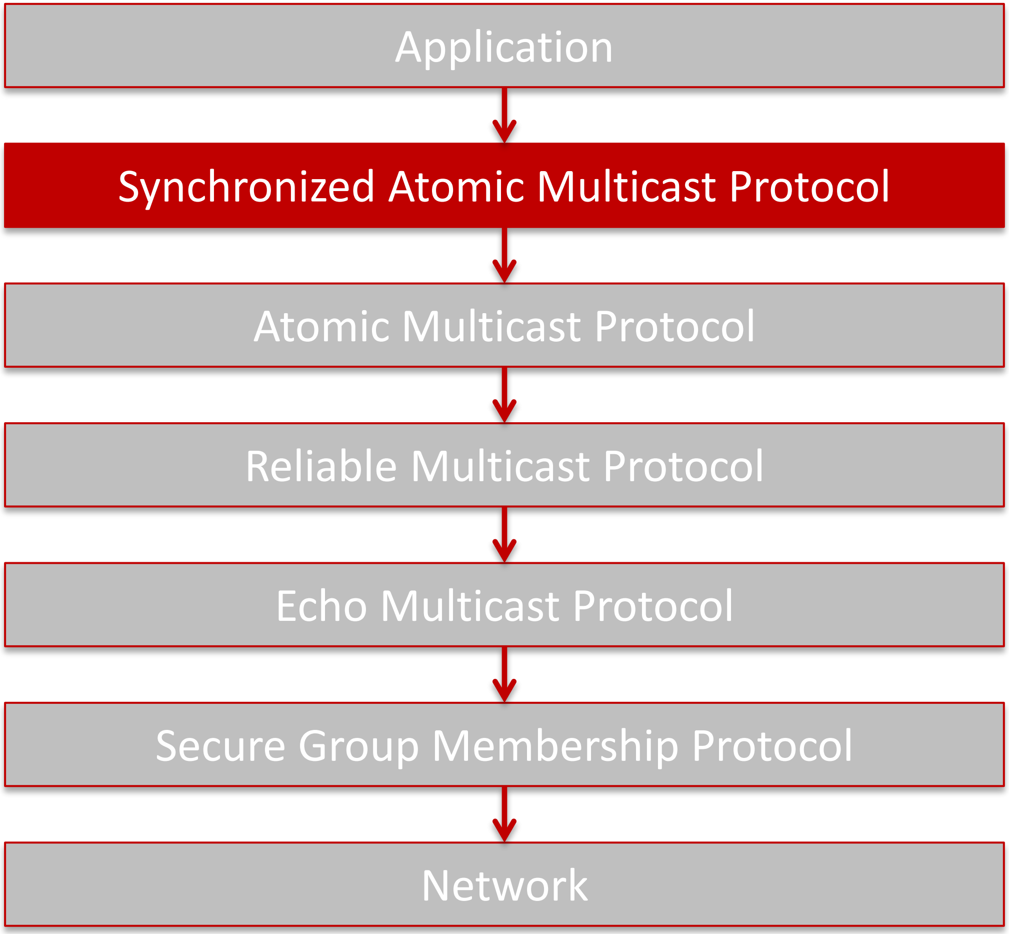
Messages at party p_1:

Messages	$\mathit{Pending}_{p1}$	$\mathit{Pending}_{p\ldots}$	$\mathit{Pending}_{pn}$
m_1 from p_1	m_1		
m_3 from p_1	m_1, m_3		
m_2 from p_n	m_1 , m_3		m_2
‹Order: *Senders*› from p_n			

Messages at party p_n (the sequencer):

Messages	$\mathit{Pending}_{p1}$	$\mathit{Pending}_{p\ldots}$	$\mathit{Pending}_{pn}$	*Senders*
m_1 from p_1	m_1			p_1
m_2 from p_n	m_1		m_2	p_1, p_n
m_3 from p_1	m_1, m_3		m_2	p_1, p_n, p_1
‹Order*: Senders*› from p_n				

Synchronized Atomic Multicast Protocol



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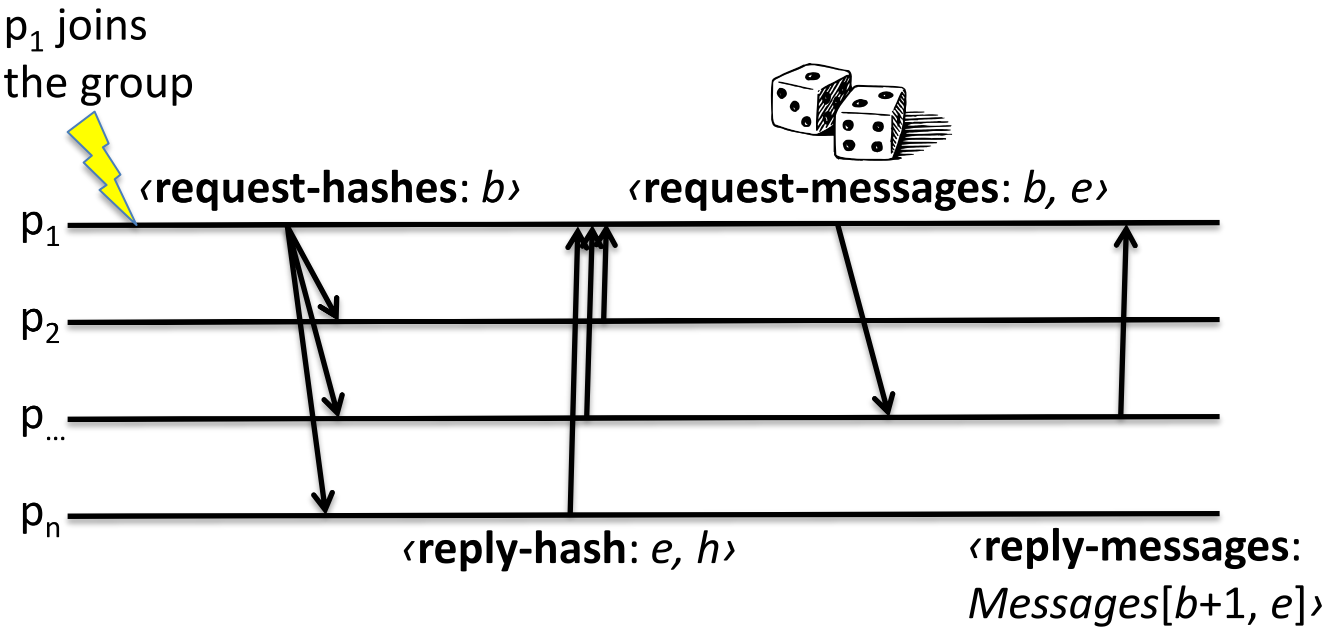
Synchronized Atomic Multicast Protocol (1/2)

- Uses the Atomic Multicast Protocol.
- Synchronizes messages at parties (re)joining the group.

Synchronized Atomic Multicast Protocol (2/2)



p_1 joins the group

‹**request-hashes**: *b*›

‹**request-messages**: *b, e*›

p_1

p_2

$p_{\dots}$

p_n

‹**reply-hash**: *e, h*›

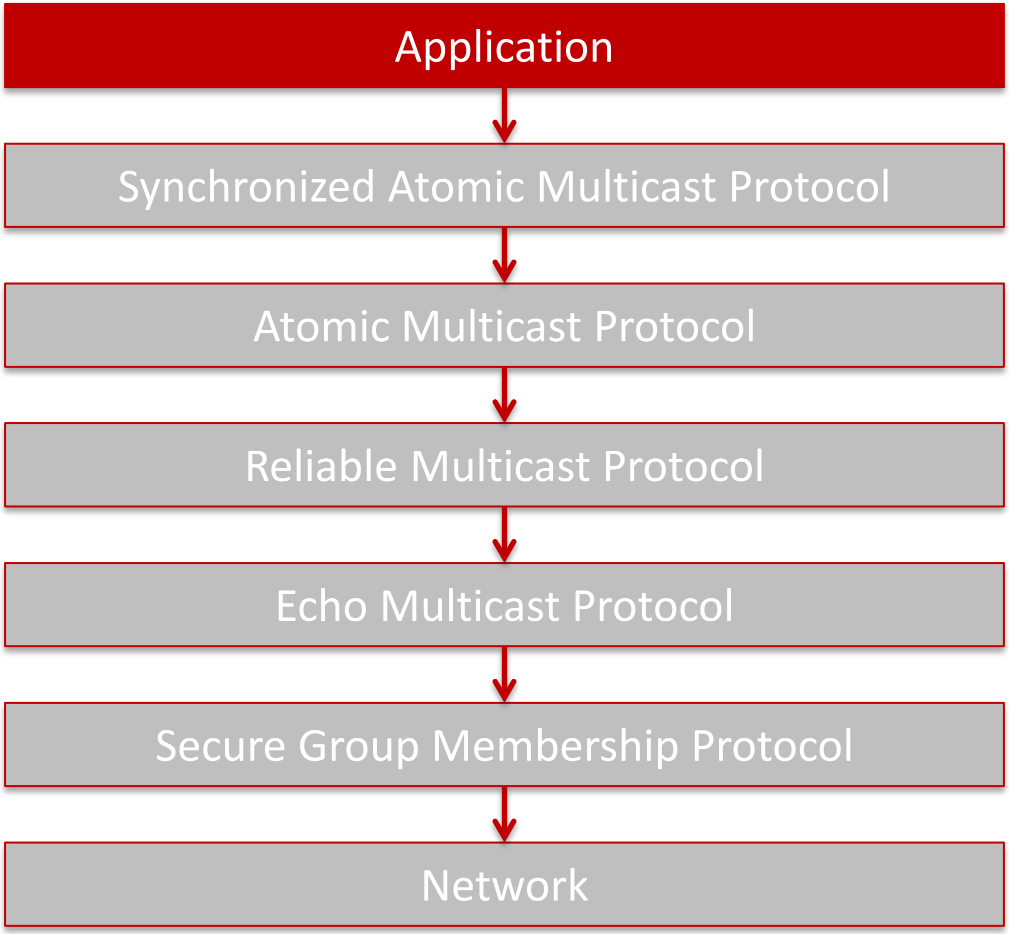
‹**reply-messages**: *Messages*[*b*+1, *e*]›

b: amount of already received messages

e: amount of missing messages

h: hash of the missing messages

Application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Application

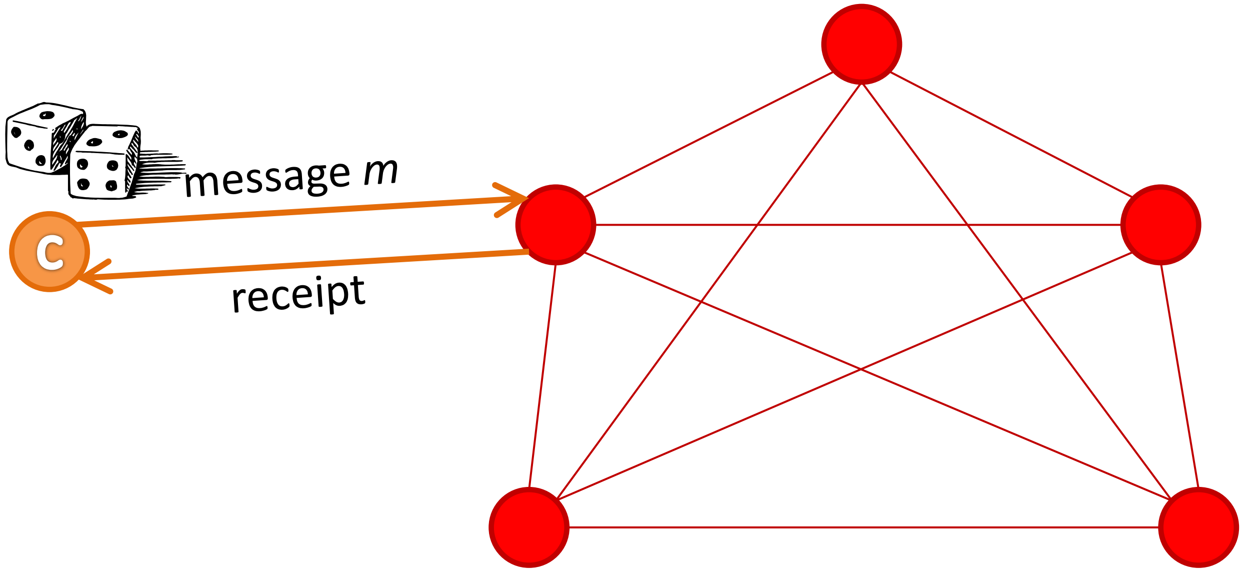
- Depends of the context.
- Consists of three protocols:
  - The Server Protocol
  - The Client Writing Protocol
  - The Client Reading Protocol

The Server Protocol (1/3)

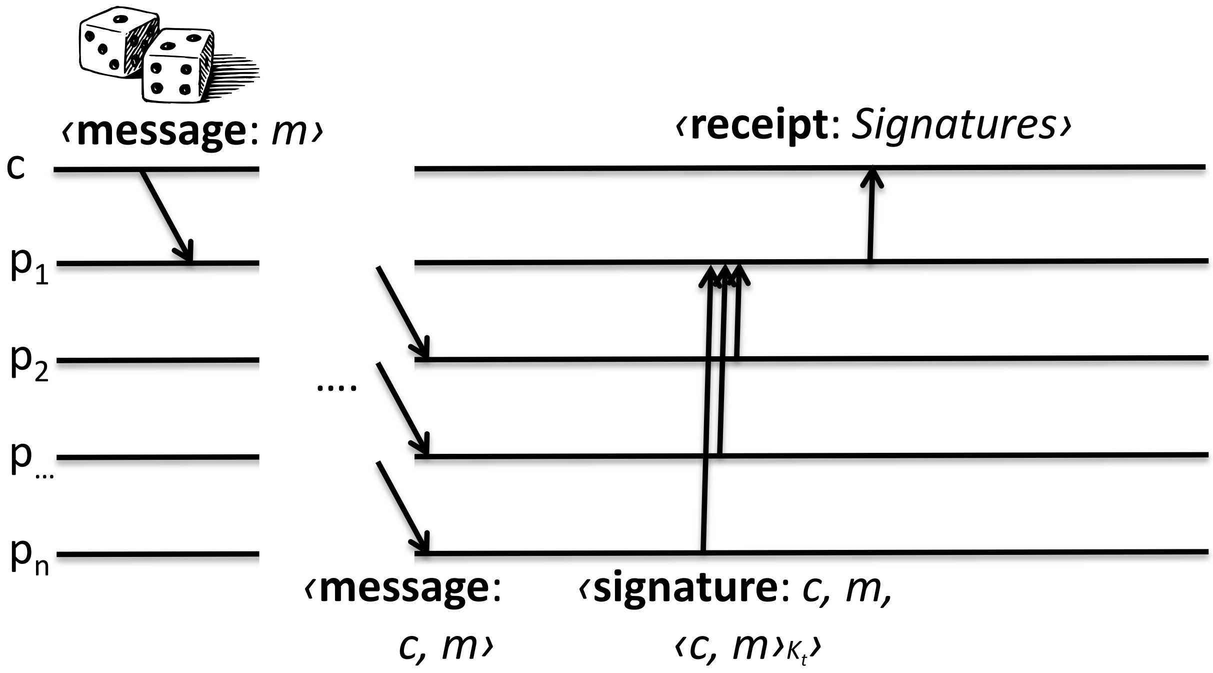
- Receives messages from clients and multicast them to the other parties using the Synchronized Atomic Multicast Protocol.
- Persists the messages.
- Sends receipts to the clients.
- Answers read requests.

The Client Writing Protocol

- A client *c* randomly selects one of the parties to post his message *m*.
- If the client does not receive a correct receipt in time, it selects another party.



The Server Protocol (2/3)



‹**message**: *m*›

‹**receipt**: *Signatures*›

c

p_1

p_2

$p_{...}$

p_n

....

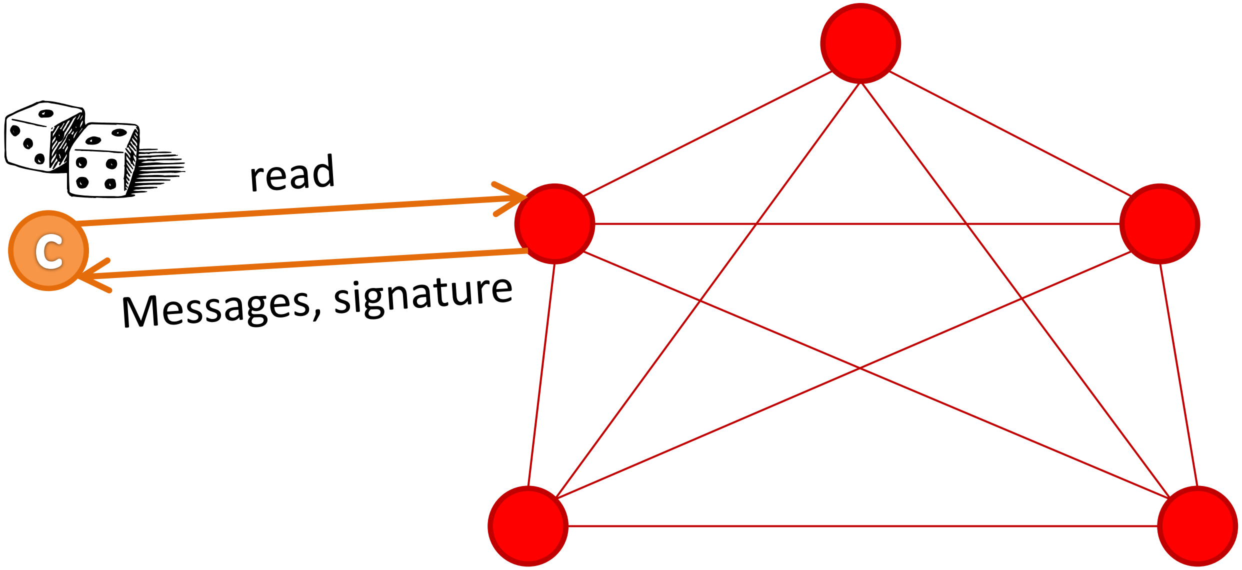
‹**message**: *c, m*›

‹**signature**: *c, m,* *‹c, m›*$_{K_t}$›

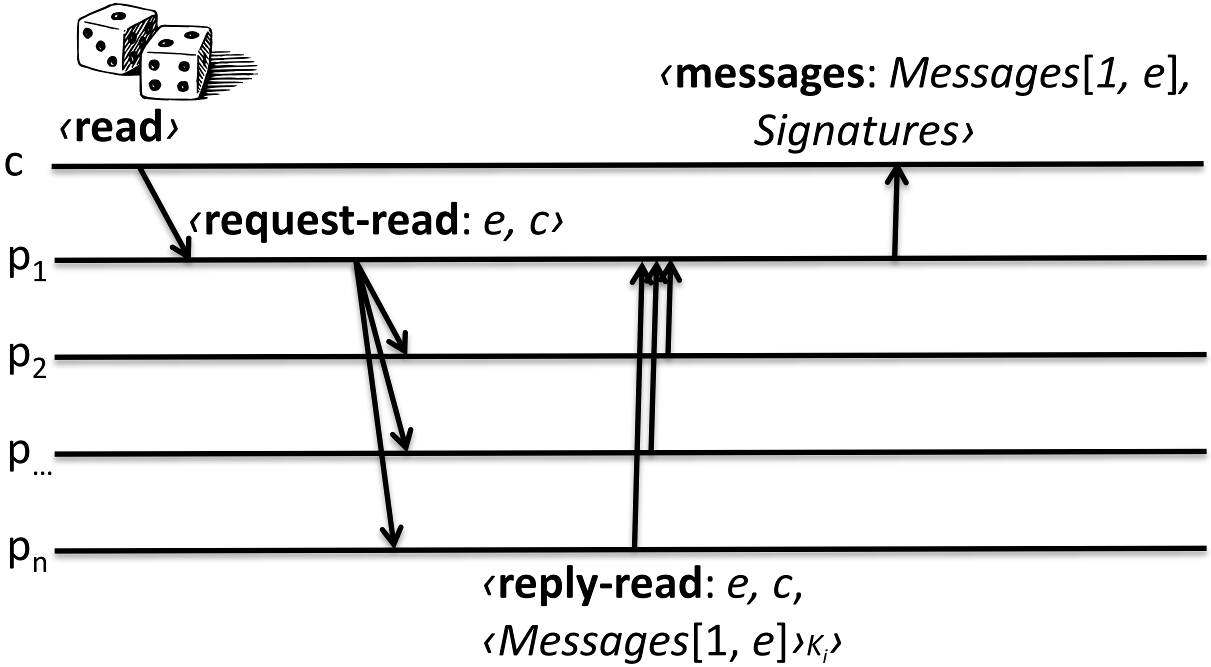
m: the message

The Client Reading Protocol

- A client *c* randomly selects one of the parties and sends a read request.
- If the client does not receive the messages and a correct signature in time, it selects another party.



The Server Protocol (3/3)



‹**read**›

‹**request-read**: *e*, *c*›

‹**reply-read**: *e*, *c*,
‹*Messages*[1, *e*]›$_{K_i}$›

‹**messages**: *Messages*[*1*, *e*],
Signatures›

e : the amount of messages at p_1

Conclusion

- Using the presented protocols, we can build a secure distributed bulletin board which satisfies the requirements.
- Implementation status.
- Future works:

  - group threshold signatures

  - persistence service

  - application (e-voting?)

Sources

- [1] Secure agreement protocols: Reliable and Atomic Group Multicast in Rampart. Michael K. Reiter, 1994.
- [2] A Secure Group Membership Protocol. Michael K. Reiter, 1996.
- [3] A Secure Bulletin Board. Richard A. Peters, 2005.