Group Address Allocation Protocol (GAAP)

draft-farinacci-pim-gaap-02

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What is GAAP?

- A totally decentralized multicast group address allocation protocol
- There is no central entity that allocates group addresses
- Group addresses allocated are guaranteed to be unique among all GAAP speakers
- GAAP nodes have zero configuration to run the protocol

Design Goals

- The protocol allocates both IPv4 and IPv6 group addresses
- Group addresses allocated will not collide in layer-2 IGMP/MLD snooping switches (multicast MACs unique)
- Works on a single subnet as well as over layer-3 infrastructures, including overlays
- Can coexist with other group allocation protocols by using an IANA GAAP allocation block
- When native multicast not available multicast-capable overlays are used

How Does it Work

- Multicast source & receiver nodes participate in the GAAP protocol
- There is an application specified group name that will map to a group address
- A group address is a hash of the group name
- GAAP nodes send Claim messages to a well-known IANA allocated GAAP group
- A Claim message contains the group name, group address, and timestamp of group address creation

How Does it Work

- Claim messages sent every 1 minute
- If a node is part of a group name and receives a Claim for the group name, it resets the 1 minute timer
- If a node uses a group address found in a Claim for a different group name, a collision has occurred, first creator gets to keep the group address, later creator has to rehash
- Nodes that detect a collision set a 1 second random delay timer to trigger a Claim message
- Other nodes with the same group name, suppress sending triggered Claim
- Nodes part of collided group address, will rehash with string "<group-name>+1" as input to hash, then sends Claim for new group address

Partition Repair

- When a network partition occurs, not all app nodes will see Claim messages
- During this time, collisions can occur and all or part of app nodes could use the same collided address in their partition
- When the partition heals, within less than a minute, Claim messages will be received and collisions will be detected and corrected
- App nodes that have to change their address gets an app callback (supplied in **`gaap.init()`** API call) from the GAAP library
- Allows apps to start using the new address (receivers leave old group and join new group, sources start sending to new group)

Protocol Scale

- There is at most 1 Claim per group name (regardless of the number of nodes using the group name)
- There is at most 1 Claim per collided group when detected
- Collided addresses are not used and converge quickly since collision detector triggers Claim

Protocol Security

- All messages are encrypted with Chacha20 cipher
- Default key is group name
- Can run in hybrid mode
- Protocol can detect bad actors (sending too fast, forging timestamp, etc)
- Rekeying can occur to exclude bad actors
- Overlays can help to suppress bad actors close to source
- “Re-grouping” can help even more, so input queues don’t fill

Protocol API

- The GAAP protocol is lightweight enough to run as a library in the multicast app OS process

- API calls:

```
gaap.init(callback_fn)
address = gaap.allocate(group_name)
gaap.release(group_name)
gaap.close()
```

- Apps which participate in the same group, are started with the same group-name

- Apps can use multiple group-names since they may have requirements for multiple group address use

- A lightweight app can use a lighter-weight Restful API to a GAAP proxy node that runs the protocol (app doesn’t run the protocol directly)

Implementation

- GAAP Library - first phase in `python`
- Echo-Sender & Echo-Receiver Test App

```
es <group-name> “<message>”
er <group-name>
```

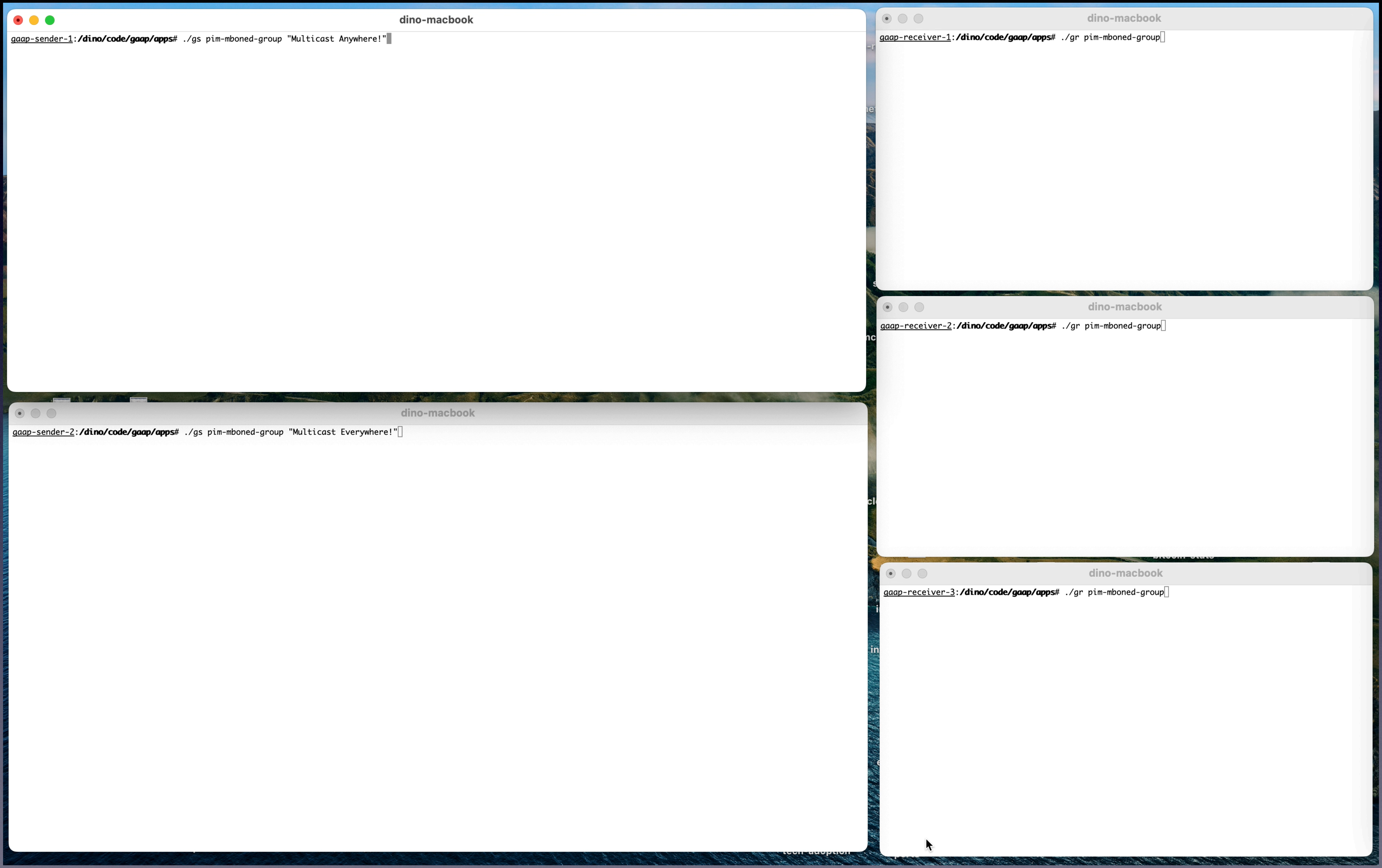
- GAAP Monitor Tool

```
gaapshark [<group-name>]
```

- Suite of GAAP Utilities

```
gaaphash, gaapscale, gaapcollide
```

App Demo - High Level



```
gaap-sender-1:/dino/code/gaap/apps# ./gs pim-mboned-group "Multicast Anywhere!"
```

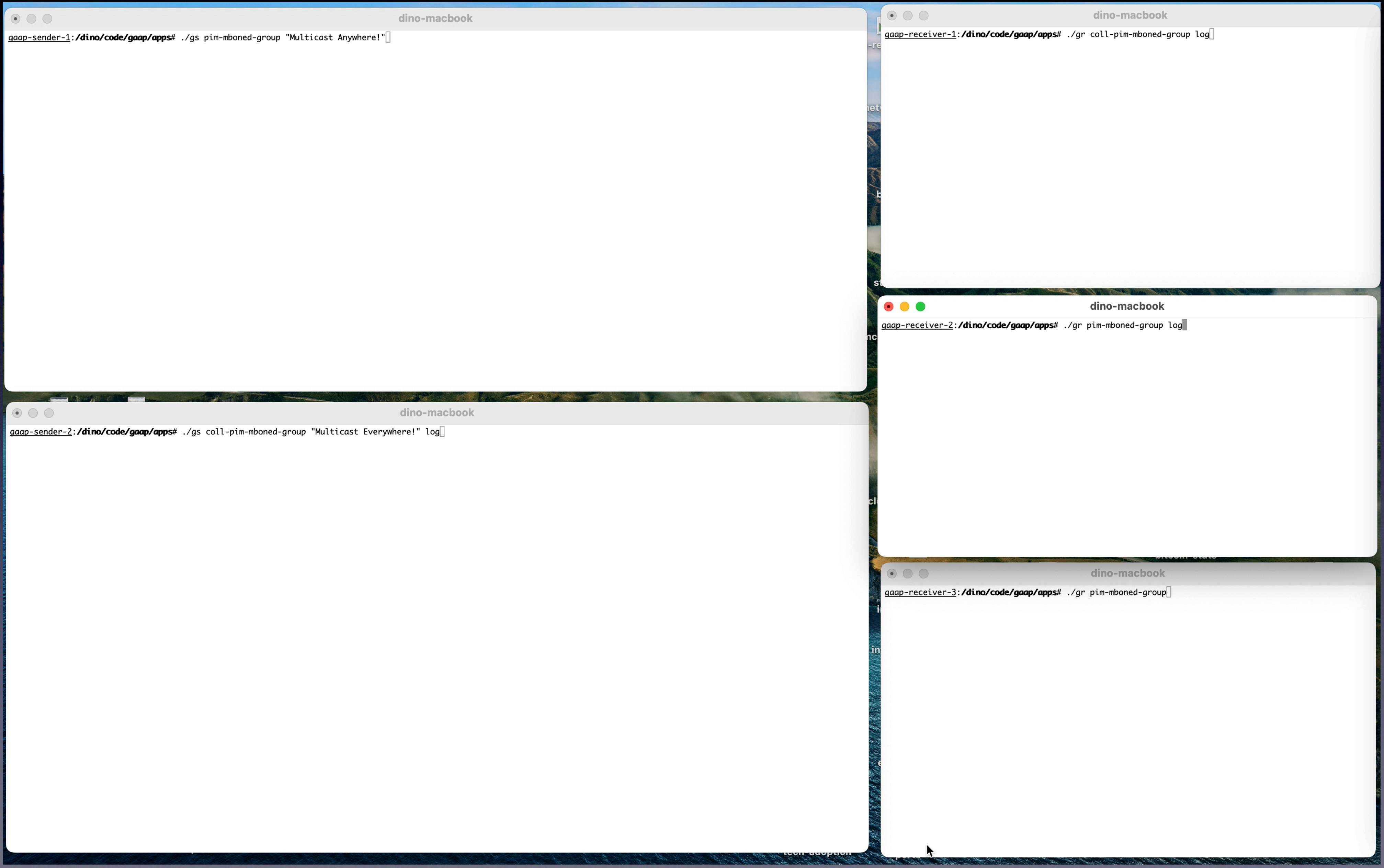
```
gaap-sender-2:/dino/code/gaap/apps# ./gs pim-mboned-group "Multicast Everywhere!"
```

```
gaap-receiver-1:/dino/code/gaap/apps# ./gr pim-mboned-group
```

```
gaap-receiver-2:/dino/code/gaap/apps# ./gr pim-mboned-group
```

```
gaap-receiver-3:/dino/code/gaap/apps# ./gr pim-mboned-group
```

Protocol Demo - Details



```
gaap-sender-1:/dino/code/gaap/apps# ./gs pim-mboned-group "Multicast Anywhere!"
```

```
gaap-receiver-1:/dino/code/gaap/apps# ./gr coll-pim-mboned-group log
```

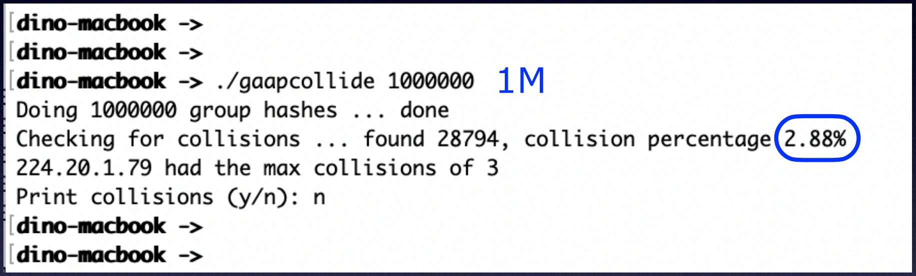
```
gaap-receiver-2:/dino/code/gaap/apps# ./gr pim-mboned-group log
```

```
gaap-sender-2:/dino/code/gaap/apps# ./gs coll-pim-mboned-group "Multicast Everywhere!" log
```

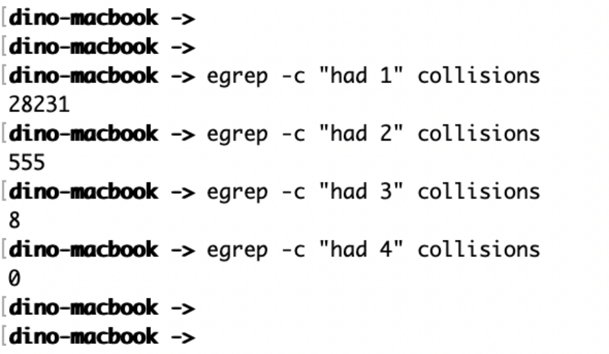
```
gaap-receiver-3:/dino/code/gaap/apps# ./gr pim-mboned-group
```

Quick Point about Collisions

- Collisions are very rare
- There is a good chance that the Collision Claim Procedures will never run

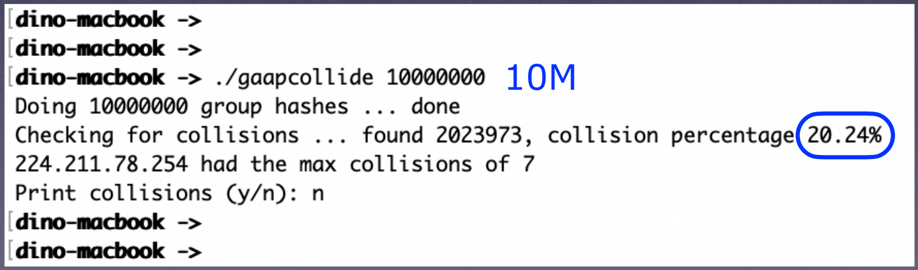


```
dino-macbook ->
dino-macbook ->
dino-macbook -> ./gaapcollide 1000000  1M
Doing 1000000 group hashes ... done
Checking for collisions ... found 28794, collision percentage 2.88%
224.20.1.79 had the max collisions of 3
Print collisions (y/n): n
dino-macbook ->
dino-macbook ->
```

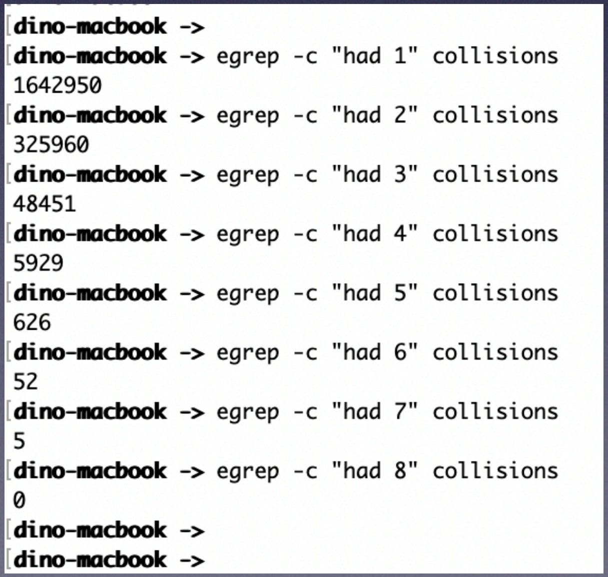


```
dino-macbook ->
dino-macbook ->
dino-macbook -> egrep -c "had 1" collisions
28231
dino-macbook -> egrep -c "had 2" collisions
555
dino-macbook -> egrep -c "had 3" collisions
8
dino-macbook -> egrep -c "had 4" collisions
0
dino-macbook ->
dino-macbook ->
```

These simulations ran with consecutive group-names



```
dino-macbook ->
dino-macbook ->
dino-macbook -> ./gaapcollide 10000000  10M
Doing 10000000 group hashes ... done
Checking for collisions ... found 2023973, collision percentage 20.24%
224.211.78.254 had the max collisions of 7
Print collisions (y/n): n
dino-macbook ->
dino-macbook ->
```



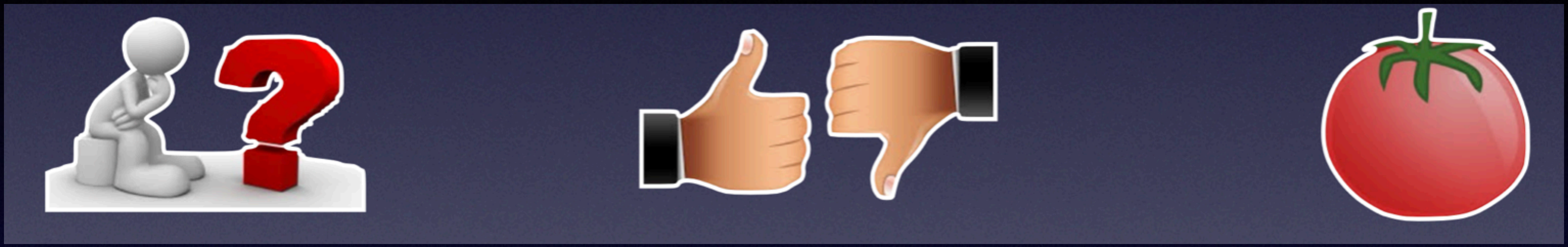
```
dino-macbook ->
dino-macbook -> egrep -c "had 1" collisions
1642950
dino-macbook -> egrep -c "had 2" collisions
325960
dino-macbook -> egrep -c "had 3" collisions
48451
dino-macbook -> egrep -c "had 4" collisions
5929
dino-macbook -> egrep -c "had 5" collisions
626
dino-macbook -> egrep -c "had 6" collisions
52
dino-macbook -> egrep -c "had 7" collisions
5
dino-macbook -> egrep -c "had 8" collisions
0
dino-macbook ->
dino-macbook ->
```

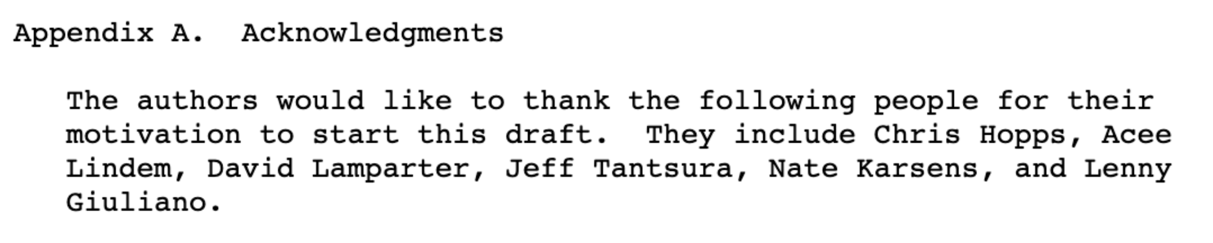
Using sha256() hash function to produce unique 24-bits

Next Steps

- More testing
- Add more security features (Shamir’s MPC Algorithm)
- Test on an overlay when no native multicast exists
- Code lightweight Restful API library
- Write more apps, suggestions?
- Seek more app developers

Questions/Reactions/Tomatoes?





```
Appendix A.  Acknowledgments

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   Lindem, David Lamparter, Jeff Tantsura, Nate Karsens, and Lenny
   Giuliano.
```

App Demo - High Level

Protocol Demo - Details