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Re: Bitcoin P2P e-cash paper

Satoshi Nakamoto Thu, 13 Nov 2008 19:34:25 -0800

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James A. Donald wrote:
> It is not sufficient that everyone knows X. We also
> need everyone to know that everyone knows X, and that
> everyone knows that everyone knows that everyone knows X
> - which, as in the Byzantine Generals problem, is the
> classic hard problem of distributed data processing.


The proof-of-work chain is a solution to the Byzantine Generals' Problem.  I'll
try to rephrase it in that context.

A number of Byzantine Generals each have a computer and want to attack the
King's wi-fi by brute forcing the password, which they've learned is a certain
number of characters in length.  Once they stimulate the network to generate a
packet, they must crack the password within a limited time to break in and
erase the logs, otherwise they will be discovered and get in trouble.  They
only have enough CPU power to crack it fast enough if a majority of them attack
at the same time.

They don't particularly care when the attack will be, just that they all agree.
 It has been decided that anyone who feels like it will announce a time, and
whatever time is heard first will be the official attack time.  The problem is
that the network is not instantaneous, and if two generals announce different
attack times at close to the same time, some may hear one first and others hear
the other first.

They use a proof-of-work chain to solve the problem.  Once each general
receives whatever attack time he hears first, he sets his computer to solve an
extremely difficult proof-of-work problem that includes the attack time in its
hash.  The proof-of-work is so difficult, it's expected to take 10 minutes of
them all working at once before one of them finds a solution.  Once one of the
generals finds a proof-of-work, he broadcasts it to the network, and everyone
changes their current proof-of-work computation to include that proof-of-work
in the hash they're working on.  If anyone was working on a different attack
time, they switch to this one, because its proof-of-work chain is now longer.

After two hours, one attack time should be hashed by a chain of 12
proofs-of-work.  Every general, just by verifying the difficulty of the
proof-of-work chain, can estimate how much parallel CPU power per hour was
expended on it and see that it must have required the majority of the computers
to produce that much proof-of-work in the allotted time.  They had to all have
seen it because the proof-of-work is proof that they worked on it.  If the CPU
power exhibited by the proof-of-work chain is sufficient to crack the password,
they can safely attack at the agreed time.

The proof-of-work chain is how all the synchronisation, distributed database
and global view problems you've asked about are solved.


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