

Perspectives on Financial Cryptography

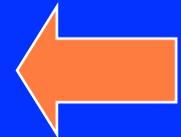
Ronald L. Rivest

MIT Lab for Computer Science

(RSA / Security Dynamics)

FC97 -- 2/27/97

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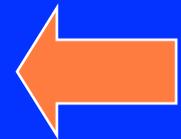
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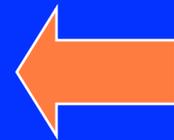


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FC97 -- 2/27/97

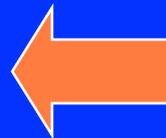


Perspectives on Financial Cryptography (Revisited)

Ronald L. Rivest

MIT Computer Science and AI Lab
(RSA)

FC06 – 2/27/06



(1997)

Outline

- ◆ I present for your consideration some *debatable propositions* about financial systems and financial cryptography.
- ◆ Warning: the propositions expressed may or may not be believed by the author, and may be phrased in a deliberately provocative manner. They may contradict each other.

(2006)

Outline

- ◆ I present for your consideration some *debatable propositions* about financial systems and financial cryptography.
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(OK)

(1997)

Internet money ==

Interstellar money (?)

- ◆ *P1: There is little difference between Internet payment schemes and interstellar payment schemes.*
- ◆ In 2097, you will buy info off the GGG (Grand Galactic Grid) with “starbucks.”

(2006) Internet money ==
Interstellar money (?)

- ◆ *P1: There is little difference between Internet payment schemes and interstellar payment schemes.*
- ◆ (“Starbucks” still a bad pun.)
- ◆ **P1: FALSE** (Internet too connected to “real world” (e.g. delivery))
- ◆ *P1’: Need “contact” to learn about “starbucks”.*

(1997)

Most schemes don't work well.

- ◆ *P2: Historically, most payment schemes haven't worked very well.*
- ◆ Ref: Weatherford, *History of Money*.
- ◆ Commodities (metal, tobacco, wampum, cocoa beans)
 - weighing, purity, quality, deterioration, transportation, storage, theft.
- ◆ Coins [Lydia, 630 B.C.]
 - Shaving, debasing, theft, government abuse.

(1997)

Most schemes don't work well...

- ◆ Paper money (China, Italy, U.S. colonies)
 - counterfeiting (scanner/printer), government abuse (inflation), or lack of money
- ◆ Checks (England, 1770)
 - Forgery, insolvency, check-washing, ...
- ◆ Credit cards (U.S., 1950 Diner's Club)
 - theft, counterfeiting, non-payment, ...
- ◆ Electronic money
 - ?? hyperinflation, system collapse, criminal activities protected by anonymity, ... ??

(2006)

Most schemes don't work well.

- ◆ *P2: Historically, most payment schemes haven't worked very well.*
- ◆ **P2 still somewhat true.**
- ◆ **Hyperinflation in MMORPG's.**
- ◆ **But getting better at “risk management.” (e.g. CYOTA)**
- ◆ *P2': Payment systems will continue to improve and be more robust and reliable.*

(1997)

Everyone will “make money”

- ◆ *P3: Electronic cash systems will enable anyone with a PC to be a “mint” for his own brand of currency.*
- ◆ World is becoming more decentralized, more distributed, more “democratic”.
(Compare with printing press.)
- ◆ Multiple (thousands) of currencies will exist and be traded. Appropriate discount rates will be used for poorly-rated issuers.
- ◆ Central banks have a smaller role to play.

(2006)

Everyone will “make money”

- ◆ *P3: Electronic cash systems will enable anyone with a PC to be a “mint” for his own brand of currency.*
- ◆ **P3 Technically true, but FALSE in practice. Continued dominance of large financial institutions and a few significant currencies.**
- ◆ *P3’*: P3 will remain false.

(1997)

The dollar stays around.

- ◆ *P4: National currencies won't go away, to be replaced by cyberspace dollars.*
- ◆ *Ref: The Sovereign Individual (James Davidson and Lord William Rees-Mogg), for contrary view: governments will implode as debts spiral and tax base disappears into cyberspace tax havens.*

(2006)

The dollar stays around.

- ◆ *P4: National currencies won't go away, to be replaced by cyberspace dollars.*
- ◆ **P4: TRUE.**
- ◆ *P4': P4 remains true.*

(1997)

Privacy is already lost

- ◆ *P5: Individual privacy is already lost, and must be regained.*
- ◆ All information about individual is now electronic form, and is bought and sold.
- ◆ There is strong economic incentive for “user profiling” by merchants, card issuers, etc...

(2006)

Privacy is already lost

- ◆ *P5: Individual privacy is already lost, and must be regained.*
- ◆ **P5 TRUE. Current business and government policies intrude ever more deeply into “personal” realm...**
- ◆ *P5': People may not care...*

(1997)

User Profiling Not So Bad?

- ◆ *P6: User profiling has a definite “up side” for the user:*
 - reduction of unwanted marketing mail; user and advertiser both agree that mail sent should be interesting to user.
 - spending profiles aid fraud detection.

(2006)

User Profiling Not So Bad?

- ◆ *P6: User profiling has a definite “up side” for the user.*
- ◆ **P6: TRUE.** (But only if it works well; my TIVO often guesses my tastes wrong...)
- ◆ *P6': Benefits of user profiling may become more evident, thus profiling more accepted.*

(1997)

No anonymity for large payments

- ◆ *P7: Governments will not allow payment systems to support true (payer or payee) anonymity for large payments.*
- ◆ This is for law-enforcement reasons:
 - payer anonymity: bribery, kickbacks, political contributions
 - payee anonymity: extortion, blackmail, kidnapping, etc.
- ◆ Anonymity will only work for small payments.

(2006)

No anonymity for large payments

- ◆ *P7: Governments will not allow payment systems to support true (payer or payee) anonymity for large payments.*
- ◆ **P7: TRUE (especially post 9/11)**
- ◆ *P7': There is not even serious debate about this anymore.*

(1997)

No anonymity for small payments

- ◆ *P8: Achieving payer anonymity for small payments by cryptographic means is too expensive (in terms of complexity and cpu time).*
- ◆ Isn't it just easier to pass very strong privacy-protection laws about the gathering and use of personal spending data?
- ◆ But costs decrease over time, too...

(2006)

No anonymity for small payments

- ◆ *P8: Achieving payer anonymity for small payments by cryptographic means is too expensive (in terms of complexity and cpu time).*
- ◆ **P8 TRUE.**
- ◆ *P8': P8 remains true; while cryptographic approaches to anonymity get more affordable with Moore's Law, anonymity is just not a driver anymore...*

(1997)

Anonymity to be bought and sold

- ◆ *P9: Anonymity will be a value-added feature that a user may purchase. Conversely, a user may break his own anonymity in a transaction, for a fee.*
- ◆ Most users may feel that anonymity is a good that he should control, and perhaps sell, but not normally a necessity.
- ◆ User may reveal his true identity, or else a pseudo-identity (to allow profiling).

(2006)

Anonymity to be bought and sold

- ◆ *P9: Anonymity will be a value-added feature that a user may purchase. Conversely, a user may break his own anonymity in a transaction, for a fee.*
- ◆ **P9 FALSE.**
- ◆ *P9': P9 remains false. The only thing most users really care about is ease-of-use (convenience).*

(1997)

No multi-app smart cards

- ◆ *P10: Multi-application smart cards will never make it big.*
- ◆ Coordinating issuers is about as easy as making peace in the Middle East.
- ◆ Security issues on a multi-app card are difficult.
- ◆ User are comfortable and familiar with having one card per issuer.

(2006)

No multi-app smart cards

- ◆ *P10: Multi-application smart cards will never make it big.*
- ◆ **P10 TRUE.** Some new payment systems appearing (e.g. Dunkin Donuts prepaid card)
- ◆ There are some signs that this may change: “octopus card” in Hong Kong...
- ◆ *P10’*: *Cell phone will become your multi-app “smart card”*

(1997)

Anonymity by smart-card choice

- ◆ *P11: Anonymity for small-value payments will arise (only) from anonymity of card-holder/card relationship.*
- ◆ Smart cards can be obtained anonymously, as frequently as desired.
- ◆ Smart card ID is a pseudonym for user. (Nyms are already understood by AOL users...)

(2006)

Anonymity by smart-card choice

- ◆ *P11: Anonymity for small-value payments will arise (only) from anonymity of card-holder/card relationship.*
- ◆ **P11 TRUE. Small pre-paid application cards (e.g. for transit) provide some anonymity.**
- ◆ *P11': P11 remains true.*

(1997)

Cost of breaking SC's to rise

- ◆ *P12: Smart cards will be “broken into” on a regular basis, but the cost of doing so will rise dramatically over the next decade.*
- ◆ Smaller feature sizes make requisite lab equipment more expensive.
- ◆ Vast number of installed smart cards will stimulate further investment into security measures and lower production costs.
- ◆ Compare: bank safes.

(2006)

Cost of breaking SC's to rise

- ◆ *P12: Smart cards will be “broken into” on a regular basis, but the cost of doing so will rise dramatically over the next decade.*
- ◆ **P12: TRUE.** (Depending on def'n of “regular”) We are presumably getting better at designing secure chips.
- ◆ *P12': RFID chip security will be the most interesting battleground. (These are not so “smart”, but they will be pervasive.)*

(1997)

No large-value digital coins

- ◆ *P13: Digital coins will not be used for large-value transactions.*
- ◆ In a coin-based system (as opposed to an account-based system), possession of bits means possession of value. Replication!
- ◆ Identification of double-spenders is unlikely to be a sufficient deterrent to prevent major fraud. (Compare with credit-card theft .)

(2006)

No large-value digital coins

- ◆ *P13: Digital coins will not be used for large-value transactions.*
- ◆ **P13 TRUE (also true for small-value; digital coins aren't being used at all).**
- ◆ *P13': Digital coins will never make it – all electronic payment systems will essentially “account-based”.*

(1997)

No transferable coins!

- ◆ *P14: Payment schemes with off-line coin transfers between users won't make it.*
- ◆ Need will decrease dramatically as every device and individual can be “on-line” whenever it wants to.
- ◆ No good business model: what does issuer gain by allowing transferability? (Extra “float” doesn't compensate for extra risk. Compare with early US bank notes...)

(2006)

No transferable coins!

- ◆ *P14: Payment schemes with off-line coin transfers between users won't make it.*
- ◆ **P14 TRUE.**
- ◆ *P14': (Same as P13': digital coin systems won't make it in general.)*

(1997)

Micropayments will thrive

- ◆ *P15: Micropayment schemes will be the system of choice for purchasing most information over the Web.*
- ◆ Most information is low-value (<10 cents).
- ◆ Significant “price umbrella” underneath credit-card transactions (29 cents + 2%).
- ◆ Latency of response is important. (Not enough time for “serious crypto”.)

(2006)

Micropayments will thrive

- ◆ *P15: Micropayment schemes will be the system of choice for purchasing most information over the Web.*
- ◆ **P15 FALSE.** Ad-based systems dominate micropayment schemes for this purpose.
- ◆ *P15': While "small payment" schemes may thrive, true "micro" payment schemes may never make it. (Note Peppercoin now focuses on "small payments" not "micropayments"...)*

(1997)

General PKI's not necessary

- ◆ *P16: General-purpose public-key infrastructures (PKI's) are not necessary for financial cryptography---they can (and will) be special-cased.*
- ◆ Name/key binding may be less important than attribute binding (e.g. account is in good standing; merchant has few problems).

(2006)

General PKI's not necessary

- ◆ *P16: General-purpose public-key infrastructures (PKI's) are not necessary for financial cryptography---they can (and will) be special-cased.*
- ◆ **P16 TRUE.**

(1997)

Money and voting are close.

- ◆ *P17: Voting systems and payment systems will be seen as being very close.*
- ◆ Voting for candidate is like giving \$1 coin to candidate so she can bid for and “buy” election. (Special “registrar currency”.)
- ◆ Anonymity of voting is *necessary*. (This is a great example against key escrow or key recovery.)

(2006)

Money and voting are close.

- ◆ *P17: Voting systems and payment systems will be seen as being very close.*
- ◆ **P17 FALSE.** The closer one looks at voting, the more the similarities seem superficial. (E.g. “selling one’s vote” has no real counterpart; “trusted third parties” are perhaps less trusted; no analogue for “universal verification”, etc.)

(1997)

You can get anything you want...

- ◆ *P18: “Alice’s crypto restaurant” can serve up any feasible combination of system requirements at a workable cost (not necessarily cheap).*
- ◆ Be careful what you ask for...
- ◆ Some problems are not technical, but socio-political (whom do you trust?---key recovery, etc.)

(2006)

You can get anything you want...

- ◆ *P18: “Alice’s crypto restaurant” can serve up any feasible combination of system requirements at a workable cost (not necessarily cheap).*
- ◆ **P18 TRUE. (Even more so with magic of elliptic curves and bilinear maps in many cases.)**

(2006)

How did I do?

- ◆ **13/18 TRUE... I get a “B”...??**
- ◆ **More important than accuracy: were the questions good ones?**
- ◆ **Scientists are typically over-optimistic in short term, but wildly under-optimistic in long term...**

(1997)

Conclusions

- ◆ “Financial cryptography” is an essential component of electronic payment schemes.
- ◆ Such schemes will augment and largely replace many existing payment schemes, and will offer new features (selective anonymity, interstellar payments...)

(2006)

Conclusions

- ◆ 1997 was an “optimistic” year, with too much emphasis on anonymity!
- ◆ The gap between the “science” of financial cryptography and the “practice” of financial transactions is large – perhaps our job is to make it even larger (!), by continuing to explore “what is possible”. Practice may (or may not) follow...