

Chaos Approach to Spectrum Management



ITU Workshop on Market Mechanisms for
Spectrum Management on January 22

Ken Umeno, Ph.D.


National Institute of Information and
Communications Technology, Japan

E-mail: [umeno at nict.go.jp](mailto:umeno@nict.go.jp)



Outline

- New Technology and New Service for Spectrum Management
- Market Efficiency for Spectrum Trading
- Chaos Approach to Spectrum Trading
- A Proposal



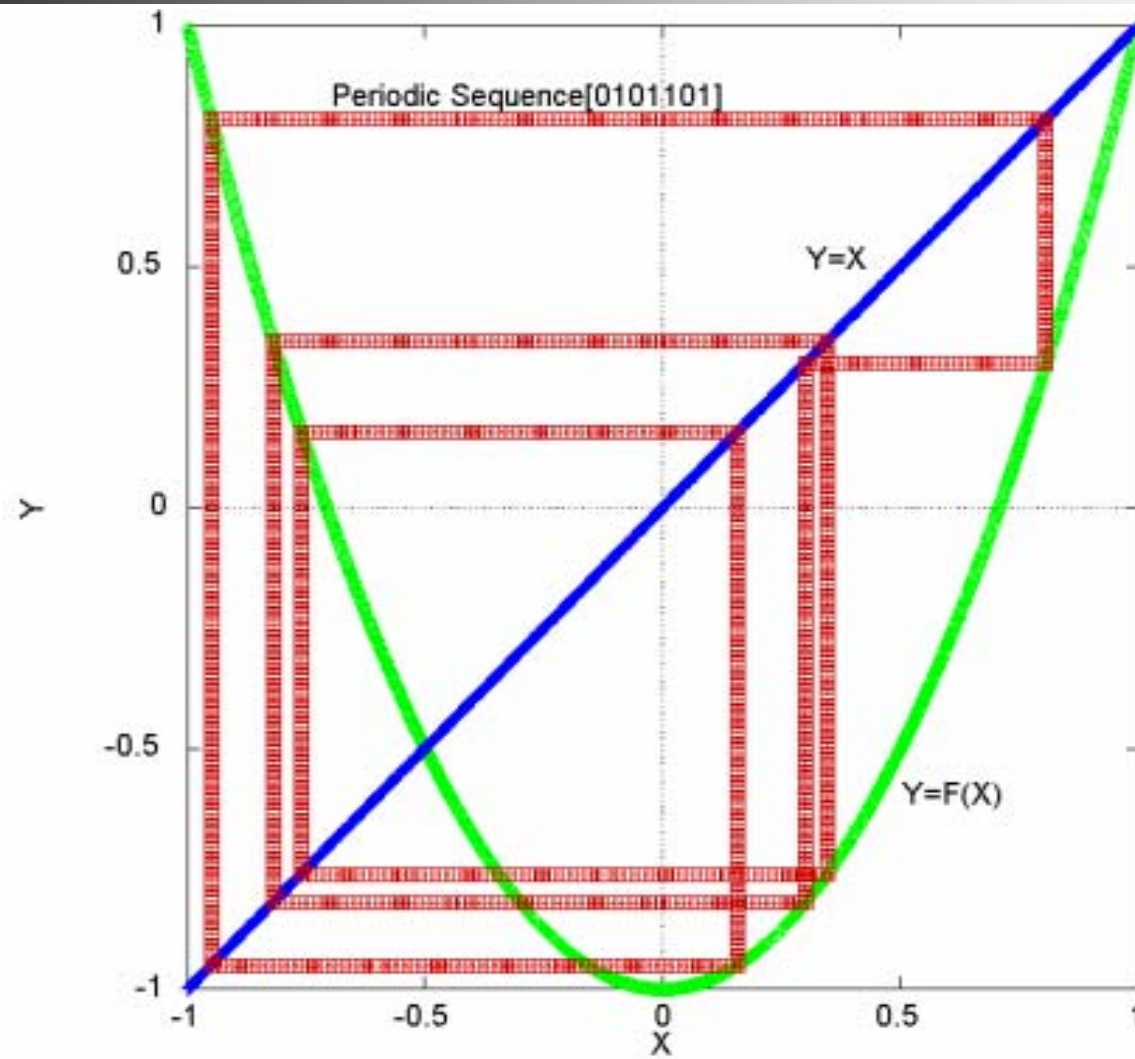
Vacuum Tube to Transistor Invention v.s. 3G to 4G

- Is it possible to develop 3G systems further to creation of 4G systems?
- Invention of New Generation Systems Requires a New Technology.
- In essence new technology cannot be born by advancing the old technology.

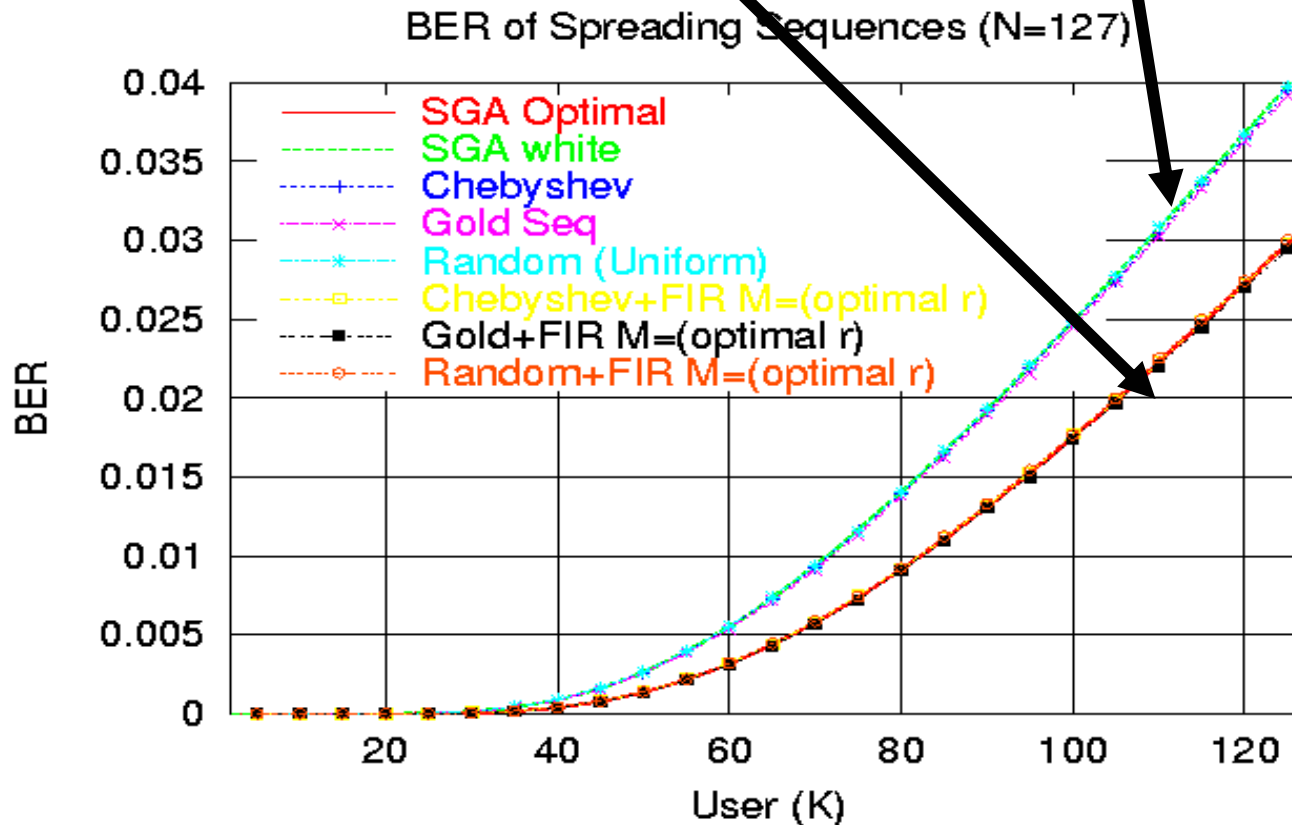
Chaotic Attractor in Electronic Circuits
(Ueda's Strange Attractor Found in 1960s.)



Chaos Codes for New Generation Communications (Invented in 1998) See the present paper in detail!



Chaos Code versus Old Code for CDMA



Chaos Communications Experiments





How about New service?



Our Simple Assumption

Market Price of Spectrum

=

Values of Spectrum Considering *All*
Kinds of Services Using Spectrum



3G and HEMINGWAY--- *The OLD MAN AND THE SEA*

He was an old man who fished alone in a skiff in the Gulf Stream and he gone eighty-four days now without taking a fish. In the first forty days without a fish the boy's parents had told him that the old man was now definitely and finally *salao*, which is the worst form of unlucky, and the boy had gone at their orders in another boat which caught three good fish the first week. It made the boy sad to see the old man come in each day with his skiff empty and he always went down to help him carry either the coiled lines or the gaff and harpoon and the sail that was furled around the mast. The sail was patched with flour sacks and furled, it looked like the flag of permanent defeat.

3G mobile phone can read

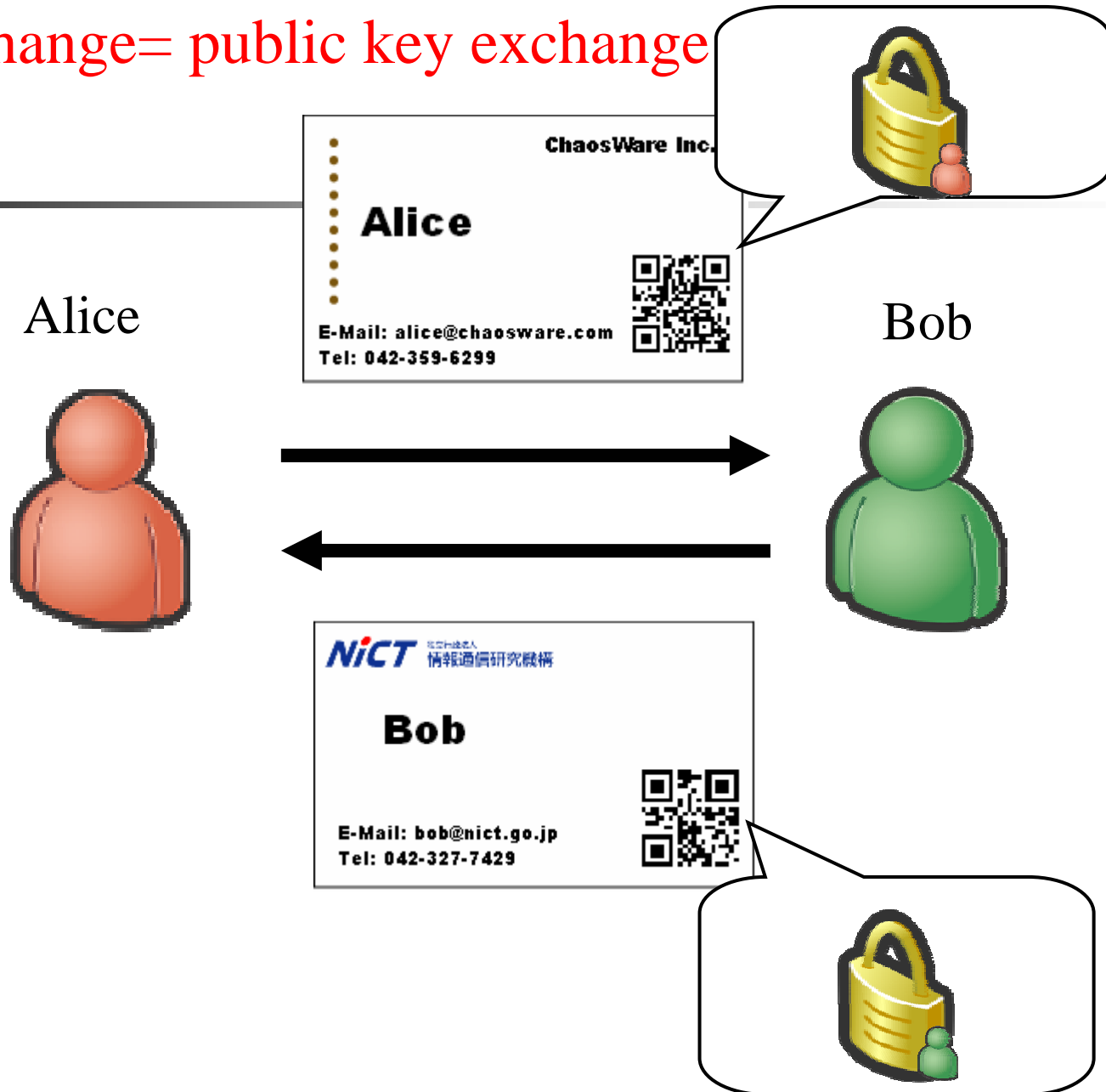
the above Hemingway as the following two-dimensional bar code (QR code)



and the transmit the Hemingway to Internet in a few seconds. (New Service of Data Transfer using Mobile Phone Are now launched.)

New PKI Service for Ubiquitous Network

- card exchange = public key exchange



Ubiquitous PKI Service Image

C.f. www.cipheron.net

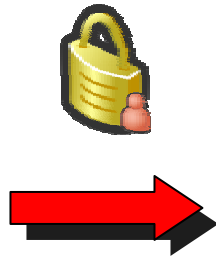
(Prototype System)

ChaosWare Inc.

Alice



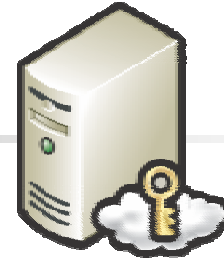
E-Mail: alice@chaosware.com
Tel: 042-359-6299



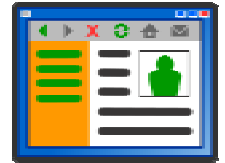
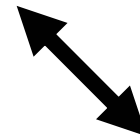
registration



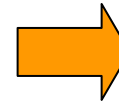
Key server



use from
web application



use for
encryption





3G Service in Japan

- 2001. 3G service (W-CDMA) started in Japan.
- 2004. QR code service started in Japan
- 2006. More than 90% new mobile phones become to be able to read a QR code.

In 2006, various new service with QR codes such as QPKI were launched in Japan.

It took 5 yeas to launch a truly new service of 3G.



Our experience shows that

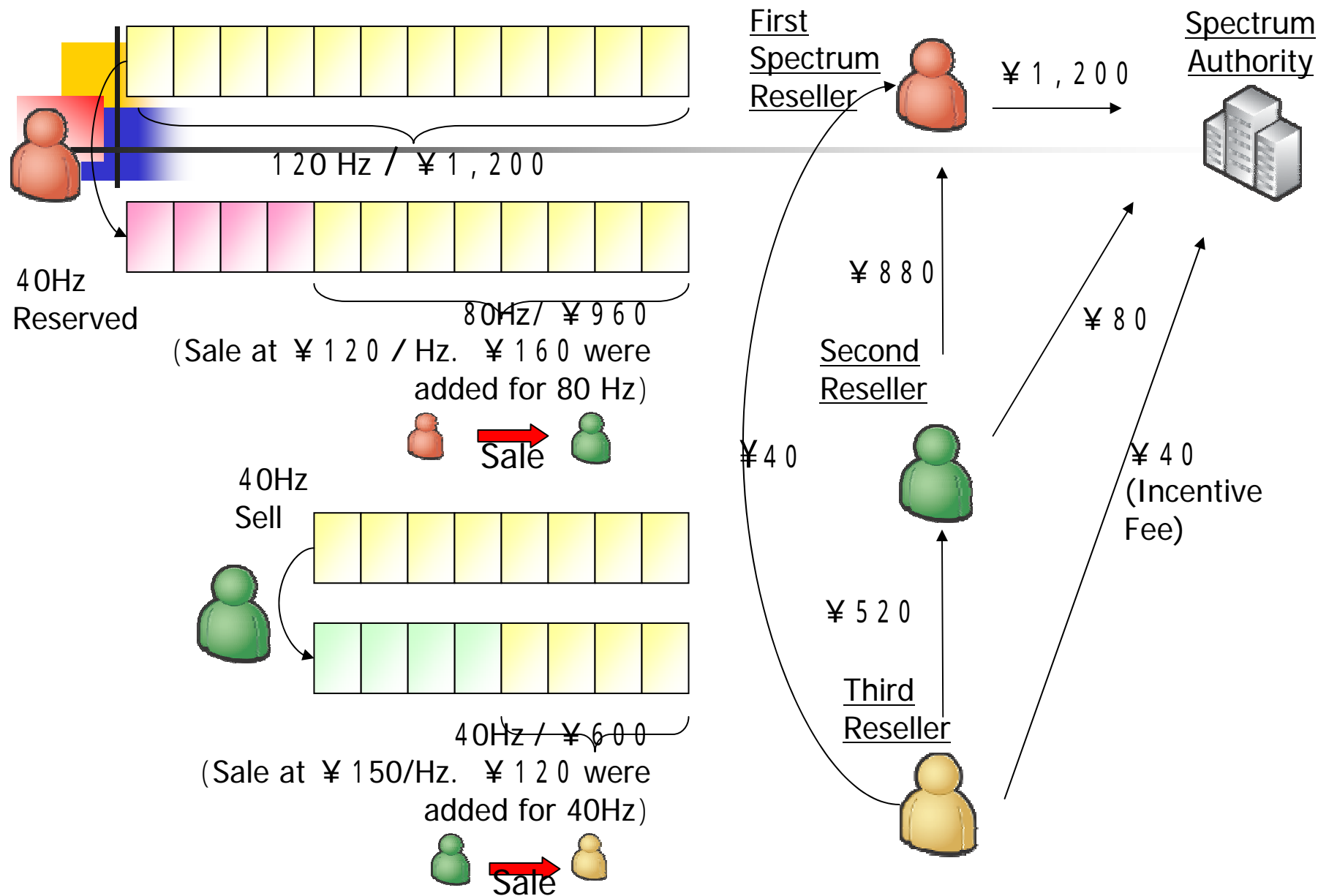
- We will see that **wireless internet access will be ubiquitous** with communications terminals such as mobile phones, PDA, vital sensors,e.t.c. in 5-10 years (soon).
- Wide Area of Services Including H to H, H to M and M to M will be realized.
- In essence, future service is **unpredictable**.
- Thus, market mechanism is needed for spectrum management with **unpredictable valued services**.



We propose a problem of

- *Efficiency Hypothesis* of Spectrum Market.
- Market efficiency can be attained by martingale stochastic processes describing some sort of *unpredictability*.
- *What is the source of unpredictability?*
- *Coexistence solution with unpredictable service and strategy Led by network operators and new service Oriented MVNOs.*

Our proposed Spectrum Re-Licensing





In this reselling models of spectrum licensing, there exist

- an incentive to create new service, by new service oriented MVNO,
- an incentive to resell spectrum licensing for a licensed network operator,
- an incentive to allow MVNO model for a government,
- and *unpredictability* in service and strategy which is the source of randomness suitable for realizing market *efficiency* for spectrum.



Thank you very much!