



**Reallocation of Radiowave Spectrum with a Price Mechanism:
Proposal of a System of Insurance and Compensation**

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I. Introduction and Background

- A. Radiowave resources
- B. History
- C. Management of spectrum
- D. Modes and institutions for spectrum management



I. Introduction and Background

A. Radiowave resources

non-reproducible, non-depletable

natural resource

a space resource

technological progress

positive and negative externalities



I. Introduction and Background

B. History

**development of the utilization of radio
spectrum**

expansion of the frequency-frontier

this frontier has nearly been exhausted

VHF or UHF bands in urban areas

carries a high economic value



I. Introduction and Background

C. Management of spectrum (1/2)

allocation of spectrum

international allocation (ITU)

national allocation (national government)



I. Introduction and Background
C. Management of spectrum (2/2)

**spectrum band divided into blocks,
frequency-wise and area-wise**

assignment of spectrum blocks to users

technological specifications



I. Introduction and Background
**D. Modes and institutions
for spectrum management**

exclusive use

command and control

market mechanism

club and commons

unlicensed band



II. Reallocation with Insurance and Compensation (RIC)

A. Outline

RIC is a mandatory insurance with compensation

**government plays role of insurance company
(compensation premium)**

$$= (\text{compensation premium rate}) * (\text{compensation amount declared})$$

selects spectrum bands to be reallocated

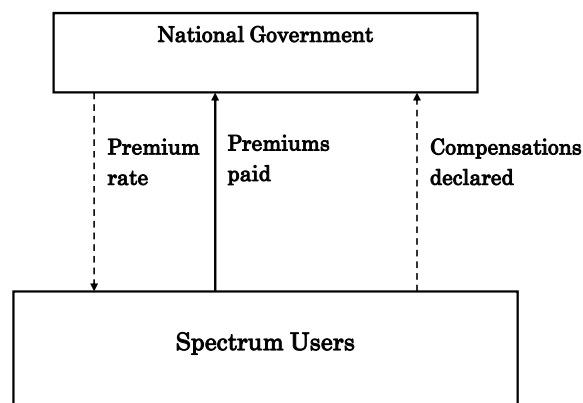
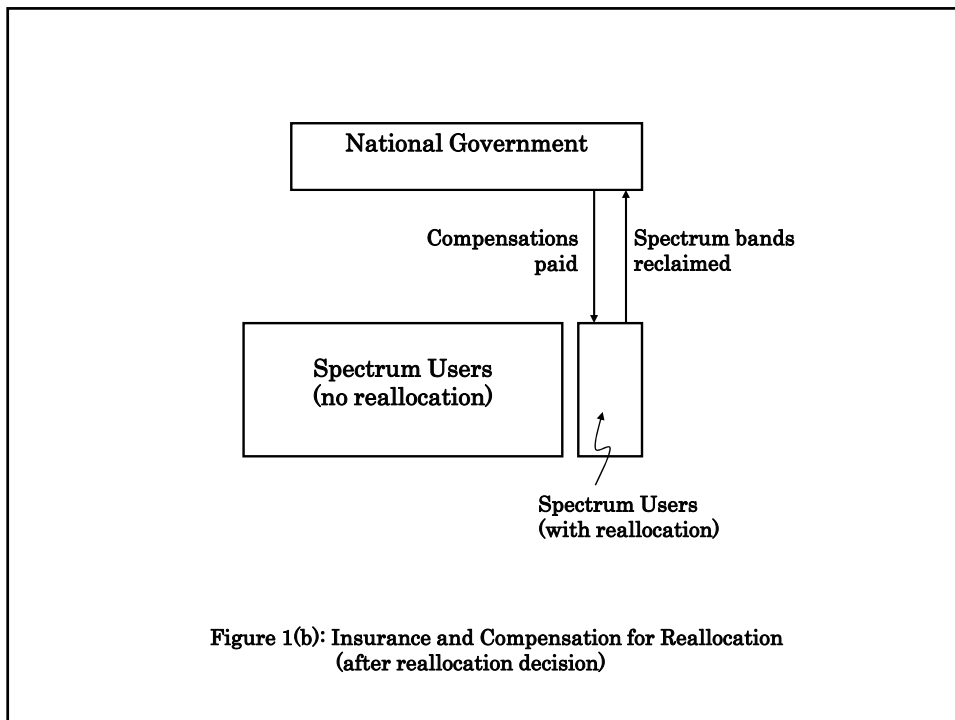


Figure 1(a): Insurance and Compensation for Reallocation
(before reallocation decision)



II. Reallocation with Insurance and Compensation (RIC)

B. Selection of spectrum bands to be reallocated

**identify new objective of using spectrum
bands**

**designate spectrum bands to be reclaimed
from current use**

II. Reallocation with Insurance and Compensation (RIC)
**C. Determination of the rate
of compensation premiums**

the RIC budget

long-run balance is desirable

**adjust the premium rate with lags toward
balancing**



II. Reallocation with Insurance and Compensation (RIC)
D. Implications of RIC as an insurance

fair insurance



II. Reallocation with Insurance and Compensation (RIC)

E. The amount of compensation declared and the supply price

RIC as a system of supply-price revelation



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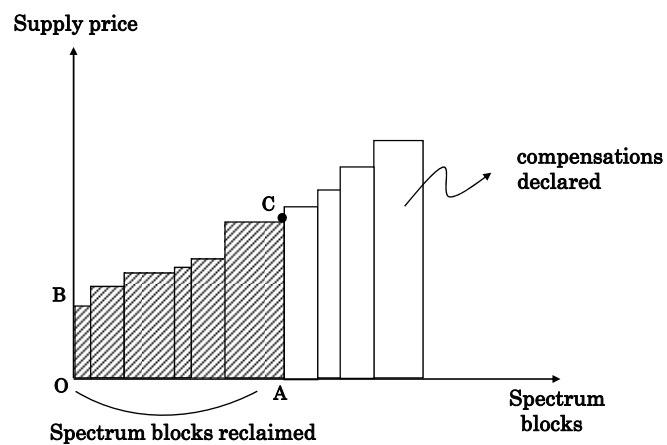


Figure 2(a): Supply of Spectrum Blocks
with regard to Reallocation (1/2)

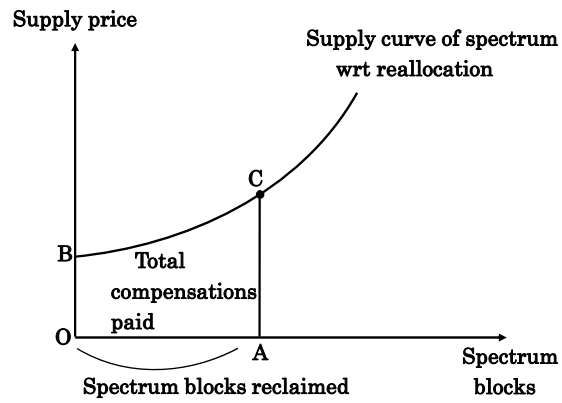


Figure 2(b): Supply of Spectrum Blocks with regard to Reallocation (2/2)

II. Reallocation with Insurance and Compensation (RIC)
F. Implications of RIC to income distribution

**cost of spectrum reallocation
borne by all users**

II. Reallocation with Insurance and Compensation (RIC)

G. On implementing RIC

implementation requires power of government

RIC resembles social insurance

implement RIC slowly and gradually

grandfathering system over spectrum assignment



III. RIC and Spectrum Assignment

A. Club or commons

RIC works quite well

users declare compensation

**with a slip to be obtained at the time a device is
purchased**

**total amount of compensations equal to sum of
declared compensations by all users**

Lindahl-Samuelson valuation



III. RIC and Spectrum Assignment

B. Market mechanism

RIC is expected to work very well

**spectrum users and government can take
spectrum prices into account**



III. RIC and Spectrum Assignment

C. Command and control

RIC still works

**spectrum users need to calculate compensation
with uncertainty**

**RIC can help government find spectrum bands
to be reclaimed**



IV. Decisions by government and the behavior of users with RIC

A. Outline

government needs to consider positive externalities of spectrum bands

speculation and manipulation by users



IV. Decisions by government and the behavior of users with RIC

B. Decision by government on the size of spectrum bands to be allocated for new objectives

efficiency-improvement index

(the efficiency-improvement index) = (PVN – Comp) / PVC

PVC = (the present value of a band with the current use)

PVN = (the present value of the band with a new use)

Comp = (the compensations to be paid for reclaiming the band)



		1	2	3	4
Current Objectives	A	a_{1A}					
	B		a_{2B}				
	C			a_{3C}	a_{4C}		
	⋮						
	⋮						
New Objectives	X	a_{1X}	a_{2X}	⋮	⋯	⋯	⋯
	Y	a_{1Y}	a_{2Y}				
	⋮	⋯	⋯	⋯	⋯	⋯	⋯

Figure 3: Matrix of Efficient-Improvement Indices

IV. Decisions by government and the behavior of users with RIC
C. Possibility of speculative behavior by users

holding-up a piece of spectrum

RIC has the power to avoid hold-up

IV. Decisions by government and the behavior of users with RIC
D. Decision by government on the selection of spectrum bands to be reallocated (1/2)

minimize compensation outlays

so that bands are located contiguously or nearby

spectrum block located strategically



IV. Decisions by government and the behavior of users with RIC
D. Decision by government on the selection of spectrum bands to be reallocated (2/2)

avoid speculations

allow spectrum users to revise compensations

disclose all information

**speculative declaration will be eliminated
gradually through competition among
spectrum users**



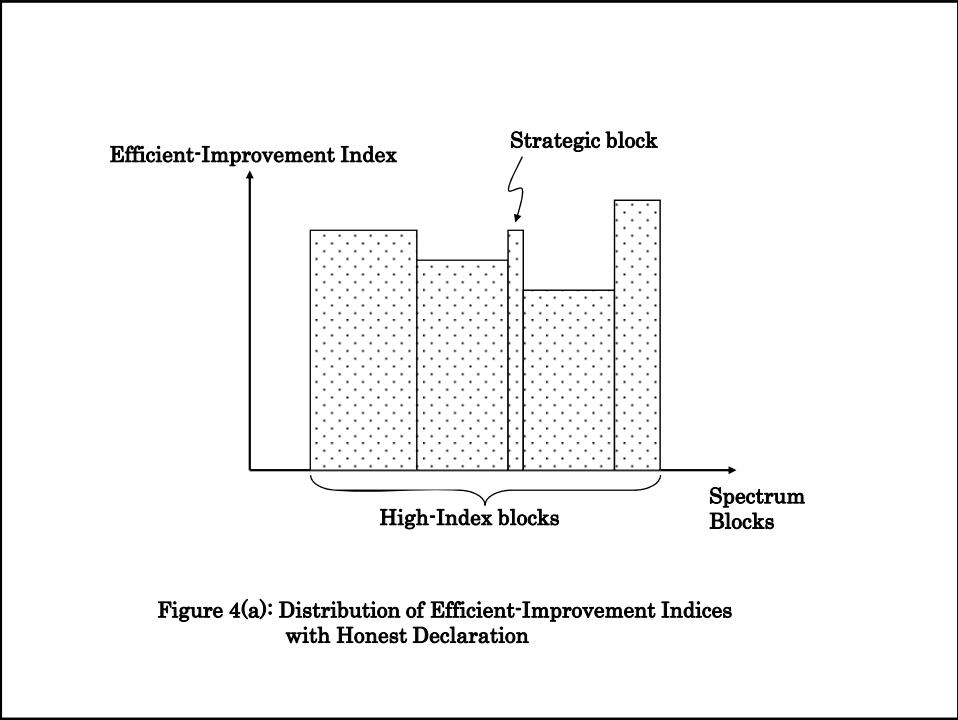


Figure 4(a): Distribution of Efficient-Improvement Indices with Honest Declaration

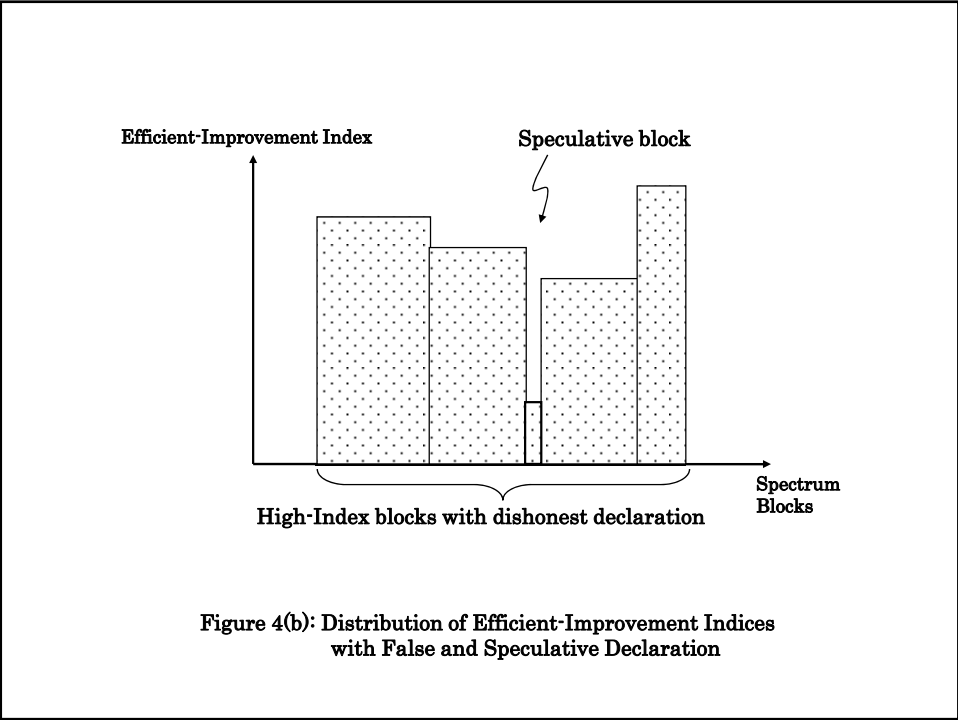


Figure 4(b): Distribution of Efficient-Improvement Indices with False and Speculative Declaration

IV. Decisions by government and the behavior of users with RIC

E. Determination of the amount of compensation by users

(the amount of compensation for reallocation)

= (the present value of future incomes with the current business without reallocation)

– (the present value of future incomes with a new business after reallocation)+ Q

Q = (the once-and-for-all cost of changing business because of reallocation)



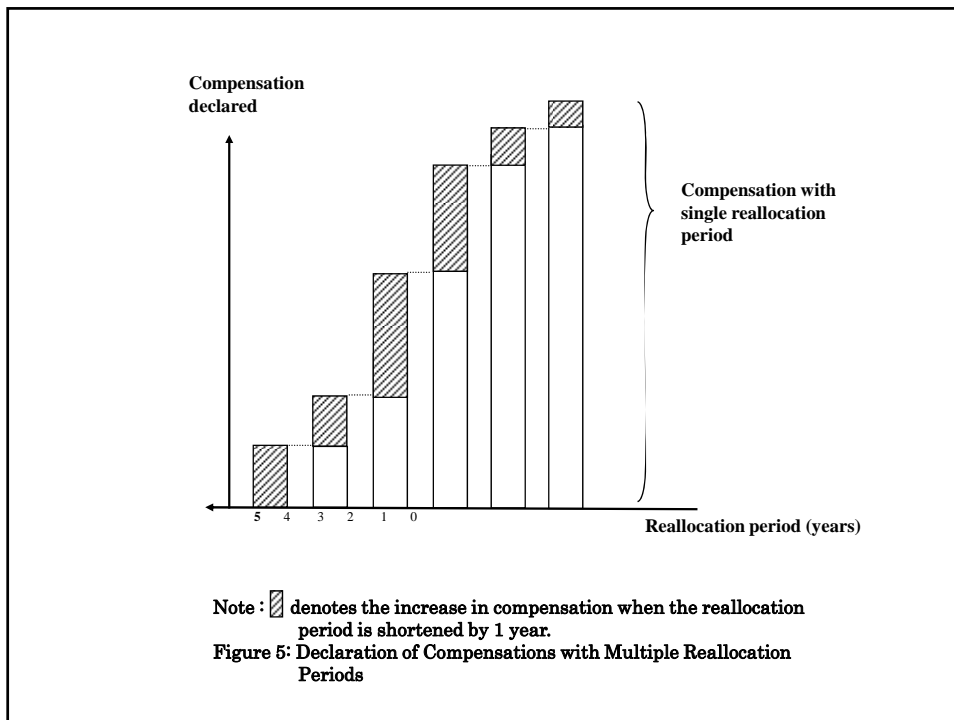
V. Extensions of RIC

A. Introduction of multiple reallocation periods

reallocation period : time period between decision of reallocation and execution

users can reveal preferences over multiple reallocation periods



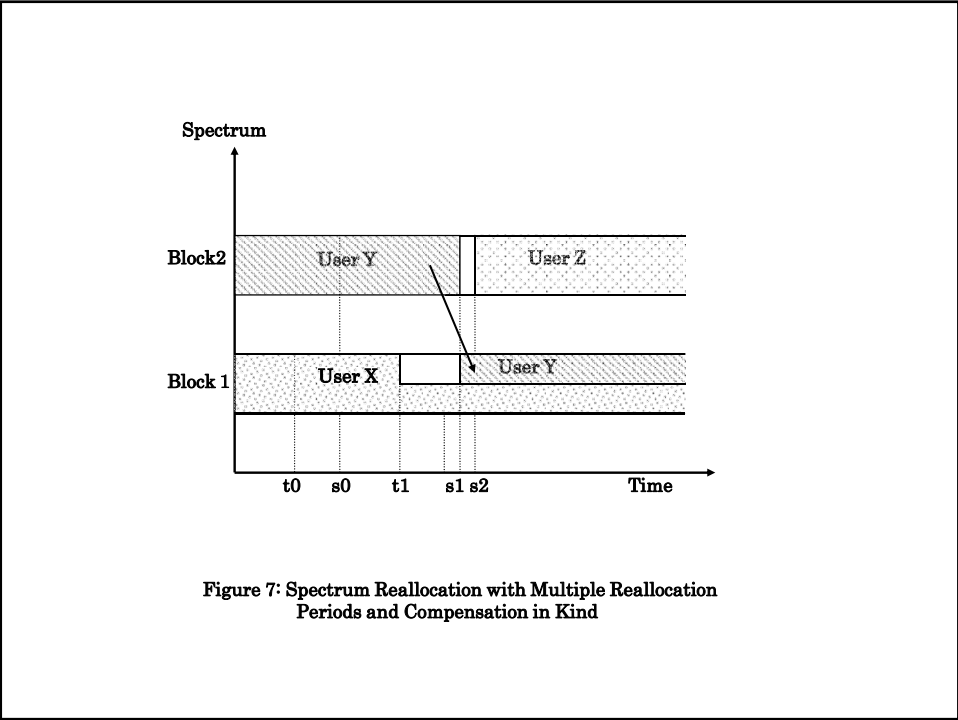
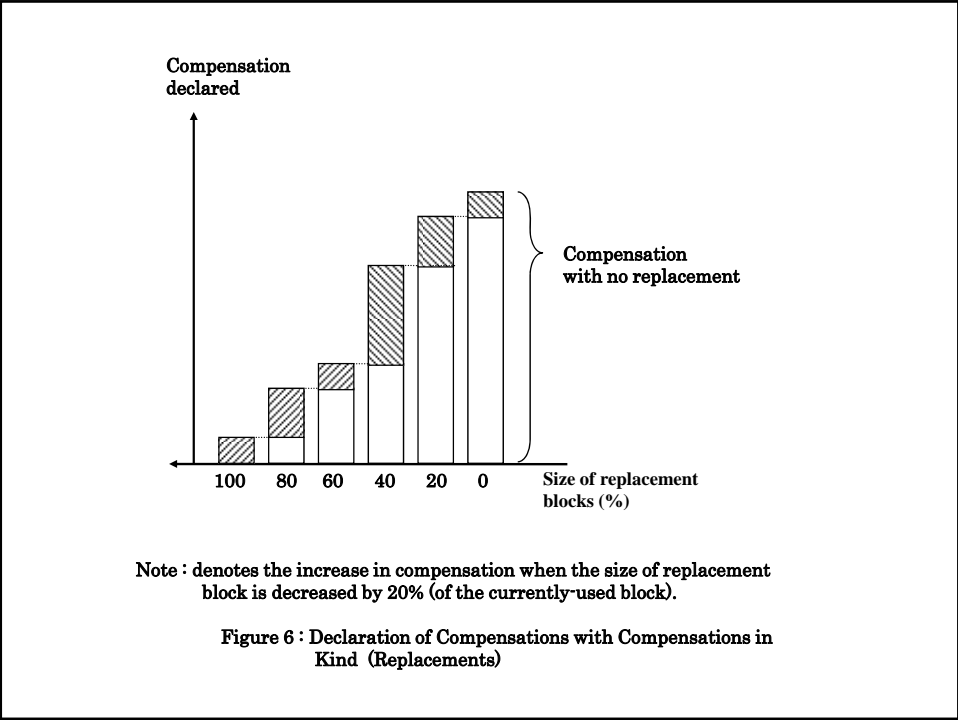


V. Extensions of RIC

B. Introduction of compensation in kind

spectrum as replacement of reallocation

users reveal preferences over different degrees of replacement



VI. RIC for International Reallocation of Spectrum (IRIC)
A. International reallocation of spectrum

International RIC

International Telecommunication Union (ITU)



VI. RIC for International Reallocation of Spectrum (IRIC)
B. Outline of IRIC

ITU plays role of national government in RIC

member countries play role of users in RIC



**VI. RIC for International Reallocation of Spectrum
(IRIC)**
C. ITU and member-countries (1/3)

ITU adopts IRIC

member countries adopt RIC

national government: transparent



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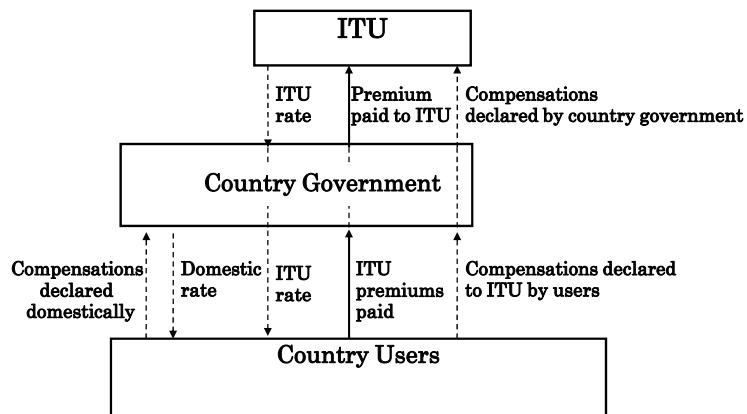
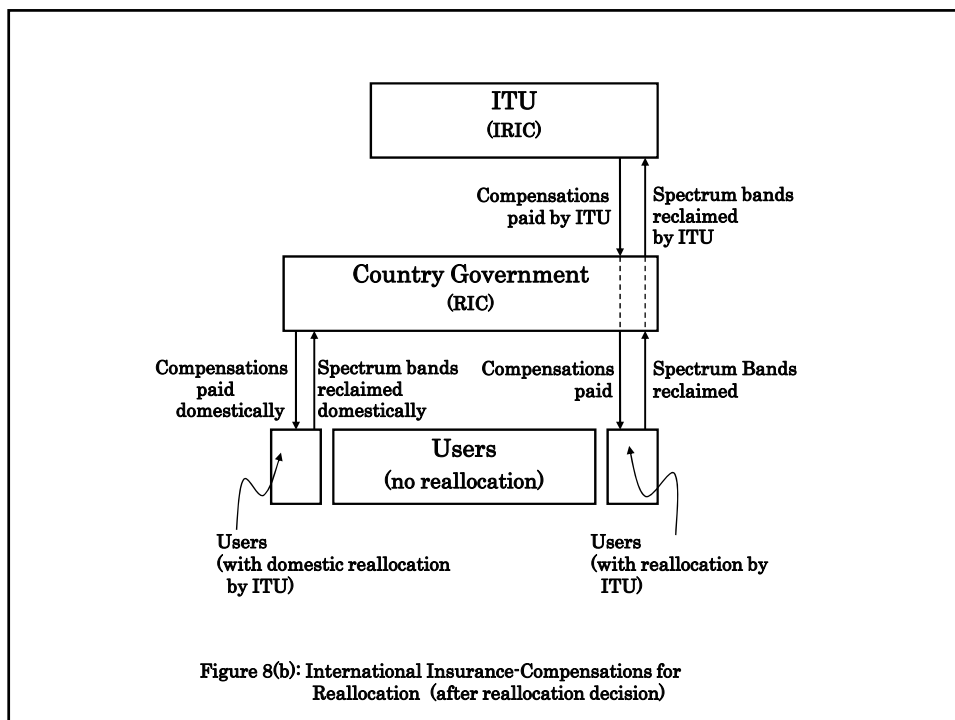


Figure 8(a): International Insurance-Compensations for Reallocation (before reallocation decisions)



VI. RIC for International Reallocation of Spectrum (IRIC)

D. ITU and member-countries (2/3)

ITU adopts IRIC

member country does not adopt RIC

national government must follow IRIC rules

national government expresses preferences in amount of money

VI. RIC for International Reallocation of Spectrum (IRIC)

E. ITU and member-country (3/3) (1/2)

ITU does not adopt IRIC

some member countries adopt RIC

domestic government can aggregate preferences of domestic users through RIC



VI. RIC for International Reallocation of Spectrum (IRIC)

E. ITU and member-country (3/3) (2/2)

GIRIC : group of countries with RIC

like Free Trade Agreement (FTA)

may simulate IRIC within GIRIC

informational benefit of RIC and IRIC as a price mechanism



