"Modified Lease Auction and Relocation--- Proposal of a New System for Efficient Allocation of Radio–spectrum Resources"

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I. Introduction

II. Factors Characterizing Usage of Spectrum Bands and Blocks

A. First-level specifications (allocation of spectrum bands, ALLOC)

B. Second-level specifications (assignment of spectrum blocks, ASSGN --- licensing)

A. First-level specifications (allocation of spectrum bands, ALLOC)

Note: (*) proposed anew in this paper

1. **Objective**
2. **Area, time (of the day, week)**
   a. **spectrum boundary (power limit)**
   b. **lease price(*)**
   c. **resale(*)**

A. First-level specifications (allocation of spectrum bands, ALLOC)

3. Priority :

primary

secondary (easement---overlay, UWB, etc.)

A. First-level specifications (allocation of spectrum bands, ALLOC)

4. Usage mode(*):

a. specified:

exclusive, shared, commons (“unlicensed”)

b. unspecified:

5. Technical specifications

B. Second-level specifications (assignment of spectrum blocks, ASSGN --- licensing)

1. **Duration**
2. **Rights and responsibilities**
   a. **spectrum boundary (power limit)**
   b. **lease price(*)**
   c. **resale(*)**
3. **Technical specifications**
4. **Selection of users**

III. Spectrum Relocation by means of Modified Lease Auction (MLA) ---The Long-run Objective---

A. Outline

B. ASSGN by means of (simple) lease auction (LA)

C. Accommodation of various usage modes within the system of LA

A. Outline

1. **ALLOC in the short run:**

   to be determined by government

2. **ASSGN**

   to be determined by government, except for the selection of user and usage fees to be determined by auction

A. Outline

3. ALLOC in the long run;:

to be adjusted by government in reference to the outcome from ASSGN

B. ASSGN by means of (simple) lease auction (LA)

1. **Spectrum resources owned by government and leased to spectrum users (managers), private or public, by auction; lease to be applied to all users including government users ----- no exception**

   give incentive to save spectrum use

B. ASSGN by means of (simple) lease auction (LA)

2. **Auction for each spectrum block --- frequency range, geographical area, time, priority**
3. **Resale of licenses ----- permitted within ALLOC and AGGGN specifications**

C. Accommodation of various usage modes within the system of LA

1. **Exclusive use:**

   winner of auction become the user

2. **Shared use:**

   winner of auction represent the share users

C. Accommodation of various usage modes within the system of LA

3. Commons use:

a. type-1 ("unlicensed" use)

winner of auction of primary exclusive right become the manager of the union of, e.g., suppliers of devices using the spectrum; union membership should be open and members pay the lease prices

C. Accommodation of various usage modes within the system of LA

3. Commons use:

b. type-2 ("overlay" including UWB)

winner of auction of secondary right

become the manager of the union of

suppliers of devices, etc.

C. Accommodation of various usage modes within the system of LA

4. Government may support commons use

government agent may bid and win auction;

the lease price is paid by government;

an upper limit of lease price is specified prior to auction

IV. Modified Lease Auction (MLA) for ASSGN and Long-run ALLOC

A. **Disadvantages of LA**

B. **Protecting incumbents against ROD to an appropriate degree**

C. **Long-run ALLOC by Government**

D. **Further consideration of ROD**

E. **Remarks**

A. Disadvantages of LA

1. **Risk of lease discontinuation (ROD) to spectrum users**

   a. **arising from newcomers outbidding incumbents (ROD1)**

   b. **arising from ALLOC decision to discontinue the current objective of spectrum usage (ROD2)**

2. **Cost of administering auctions**

B. Protecting incumbents against ROD to an appropriate degree

1. **Against ROD1 :**

   a. **discount of lease price to incumbents**

   b. **auction to be held years before the beginning of license period**

B. Protecting incumbents against ROD to an appropriate degree

1. Against ROD1 :

c. use of “pre-auction” (winners obtain discount)

d. creation of futures and options markets for leasing spectrum

B. Protecting incumbents against ROD to an appropriate degree

2. Against ROD2 ----- create "spectrum insurance:"

a. spectrum users:

i. determine amount insured -----
to be paid in case of discontinuation

ii. pay insurance fee
(= insurance-fee rate * amount insured)

B. Protecting incumbents against ROD to an appropriate degree

2. Against ROD2 ----- create "spectrum insurance:"

b. government

i. determines insurance-fee rate (so as to balance long-term revenues and payments)

ii. chooses spectrum bands for discontinuation so as to minimize the sum of insurance payments

C. Long-run ALLOC by Government

1. Gradual relocation of spectrum from low-priced to high-priced bands
2. Choice of spectrum bands to be relocated (→III. B. 2. b)

D. Further consideration of ROD

1. Economic meaning of ROD

a. the other side of economic growth

b. a price of having flexibility in spectrum use

c. no ROD in stationary (stagnant) economy

D. Further consideration of ROD

2. The degree of ROD

a. determines the balance between the security to incumbents and the chance of entry by newcomers

b. optimum to be found by trials and errors

D. Further consideration of ROD

2. The degree of ROD

c. zero: allocation by central planning (assignment by government with automatic renewals)

low: auction on the right to use spectrum permanently

medium: MLA

high: LA

E. Remarks

1. Why not perpetuity (property ownership system) ?

a. presence of externalities (scale economies) in the use of spectrum

b. Coase's theorem does not work because of uncertainty and bargaining time/cost (for Nash equilibrium with different information sets)

E. Remarks

2. Why not LA? (why are the modifications needed?)

a. with incomplete and costly information, prevalence of ROD may not be optimal.

b. positive economics for determining "optimal degree of protection against ROD"?

--- a subject for future research.

V. Gradual Transition from the Current System to the Long-term Target, MLA

A. Overview

B. Transition

C. Income Compensation

D. Forecast

A. Overview

1. Need for gradual and informed transition

a. cost of transition arising from the presence of capital stock and human skills fitted to the old system

b. information about the overall transition process is needed for the formation of transition plan by spectrum users

A. Overview

2. policies for transition

a. formation of "benchmark lease price (BLP), a proxy of market price"

b. gradual increase in usage fees from the current level (=0) to the market price (=BLP)

c. provisions for income compensation

B. Transition

1. Preparation period (M years)

a. MLA to be applied to new assignments

zero usage fees to incumbents

b. BLP: to be set at auction prices if available, else to be calculated by interpolation-periodic revisions

B. Transition

2. Execution period (N years)

a. MLA to new assignments

b. partial lease price (PLP), equal to ((n/N)* BLP), to be paid by incumbents in n-th year (n=1,2,...,N); no ROD to incumbents

B. Transition

3. Completion of transition process

a. traversing smoothly to full-scale MLA

b. all licenses to be issued under MLA with payment of full lease price (FLP) thereafter

c. resale of licenses permitted

C. Income Compensation

1. Overview

a. (possible) compensation to incumbents for the payment of PLP and FLP

b. complete separation of spectrum usage and income distribution

C. Income Compensation

2. Determination of compensation

a. compensation period : t=1,2,・・,T;no compensation for t > T

b. base amount of payment (BAP): the value of the spectrum held at t=0 evaluated in terms of current PLP or FLP, whichever applied.

C. Income Compensation

c. the degree of compensation for period t, d(t);

$$0 \leqq d(t) \leqq 1 \quad \text{for} \quad 0 \leqq t \leqq T;$$

$$d(t) = 0 \quad \text{for} \quad t > T.$$

d. linear sunset:

$$d(t) = (T - t)/T \quad \text{for} \quad 0 \leqq t \leqq T;$$

$$d(t) = 0 \quad \text{for} \quad t > T.$$

C. Income Compensation

3. Policies for compensation:

a. government determines g for each user category

near-full compensation: military and security users (g=1)

partial compensation : government users, public utilities, public transportation operators, welfare agents, etc. (g=0.5)

no compensation : profit-seeking entities, individual users (g=0)

C. Income Compensation

3. Policies for compensation:

b. actual amount of compensation in period t :

AAC(t)

$$AAC(t) = g*d(t)*BAP(t),$$

$$0 \leqq AAC(t) \leqq BAP(t), \quad t = 1,2,\ldots,T.$$

C. Income Compensation

4. Neutrality

choice of a degree of compensation d(t) does not affect the incentive to save and release spectrum by incumbents

VI. Appendix --- Economic Properties of Spectrum as a Resource

A. Space resources

B. Land and spectrum as space resources

C. Efficient allocation of space resources --- a graphical illustration

A. Space resources

1. Definition
2. Examples
3. Properties characterizing space resource
   a. technology for utilization
   b. non-depletable, non-exhaustible resource
   c. capacity

A. Space resources

3. Properties characterizing space resource

d. capital stock for utilization

e. mode of utilization

f. positive externalities

g. negative externalities

B. Land and spectrum as space resources

1. Comparison

2. Secondary space resources and layer structure

C. Efficient allocation of space resources --- a graphical illustration