

**Proposing Vertical Separation of 5G Mobile Operation
to Cope with the Natural Monopoly from Using Small Cells (Outline) ***

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Abstract

The next-generation mobile communication (the fifth generation, 5G) will use the small cell for base stations because of technical reasons. One of its implications is that, if each of the incumbent 4G operators deployed 5G services, there would be duplicated or multiplied investment in base stations, turning out with a large amount of waste of resources. This is a case of natural monopoly, of which examples are the delivery of electric power, the supply of cable television services, automobile speedway systems, and so on.

The objective of this work is to propose a scheme to cope with this problem; we will introduce vertical separation of 5G operation into upper and lower parts, each to be regulated by a public entity (regulation body, RB). In this scheme, the provider of the upper part, communications provider (CP), competitively supplies the Internet and other services to consumers, while the one of the lower part, access provider (AP), supplies wireless access services to CPs and consumers with a provision of local monopoly. The work will discuss business rules to be given to CPs and APs. Promoting competition and avoiding evils of (natural) monopoly are the objectives of this scheme.

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I. The Natural Monopoly Problem in 5G

A. Characteristics of 5G technology and natural monopoly

use of high-frequency spectrum (e.g., millimeter radio) for access services

short propagation distance,

proportional to the reciprocal of the square of the frequency

low diffraction

use of a large number of small cells (Fig.1)

duplicated/multiplicated investment

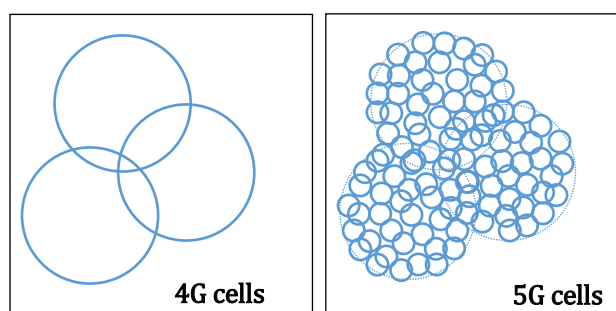


Fig. 1 Base station cells 4G and 5G

B. Alternative strategies

1. to deploy 5G in the traditional way
loss of resources from multiplicated investment
2. to have base stations shared by operators
violation of antimonopoly regulation
no possibility of new entry
3. to introduce nationwide regulated monopoly
inefficiency of monopoly operation and public regulation
going backward historically
4. to introduce a new system, “vertical separation”
the objective of this work

II. Outline of Vertical Separation

A. Guiding principles

1. separation of communications activities into
 - a. competitive domain, and
 - b. monopoly domain
2. approve monopoly in constructing base stations
“minimization” of the monopoly domain

B. Vertical separation (Figs.2a, 2b, 2c)

1. Communications Providers (CP)
 - nationwide operation, commercial
2. Access Providers (AP)
 - regulated local monopoly, commercial
3. Regulation Body (RB)
 - regulation of CPs and APs, non-commercial and public
 - to intermediate financial transactions between APs and CPs

Layer	Agent	Activities	Industrial Organization	Profit Seeking
2	Communications provider (CP)	application services, web and phone services, data transmission	Competitive	Yes
	Regulation body (RB)	administration, regulation		No
1	Access provider (AP)	construction of base stations, wireless access	Local franchised monopoly, competitive in the long run	Yes

Fig.2a Vertical separation --- outline

	Operation	Regions				
		1	2	3	.....	N
CPs	nationally	CP1, CP2,				
RB	nationally	single organization				
APs	Regional monopoly, franchised	AP1	AP2	AP3	.....	APN

Fig.2b Vertical separation --- regional view

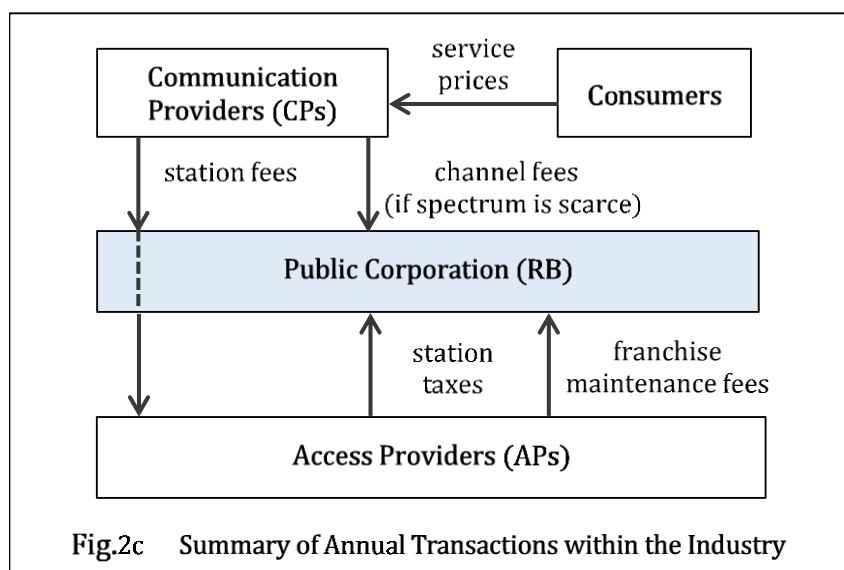


Fig.2c Summary of Annual Transactions within the Industry

III. Access Providers (AP)

A. Business principles

commercial (profit-making)

to operate in a given region, local franchised monopoly

new entry would be easier with regional operation than with nation-wide one

B. Business activities

1. construction of base stations (cells)

franchise given by RB through once-and-for-all reverse auction on station usage

fees at the beginning of 5G (→VI.C.1)

no time limit imposed to the franchise

2. provision of wireless access services (Figs.3a, 3b, 3c)

a. points of interface (POI) with CPs:

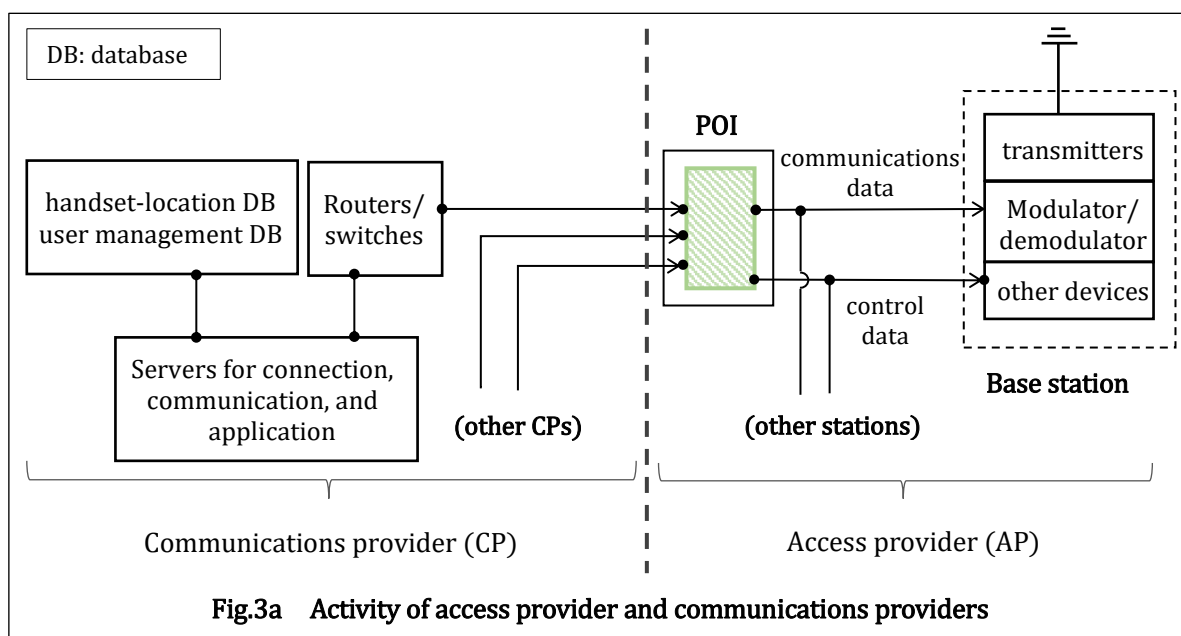
number and locations to be given by RB

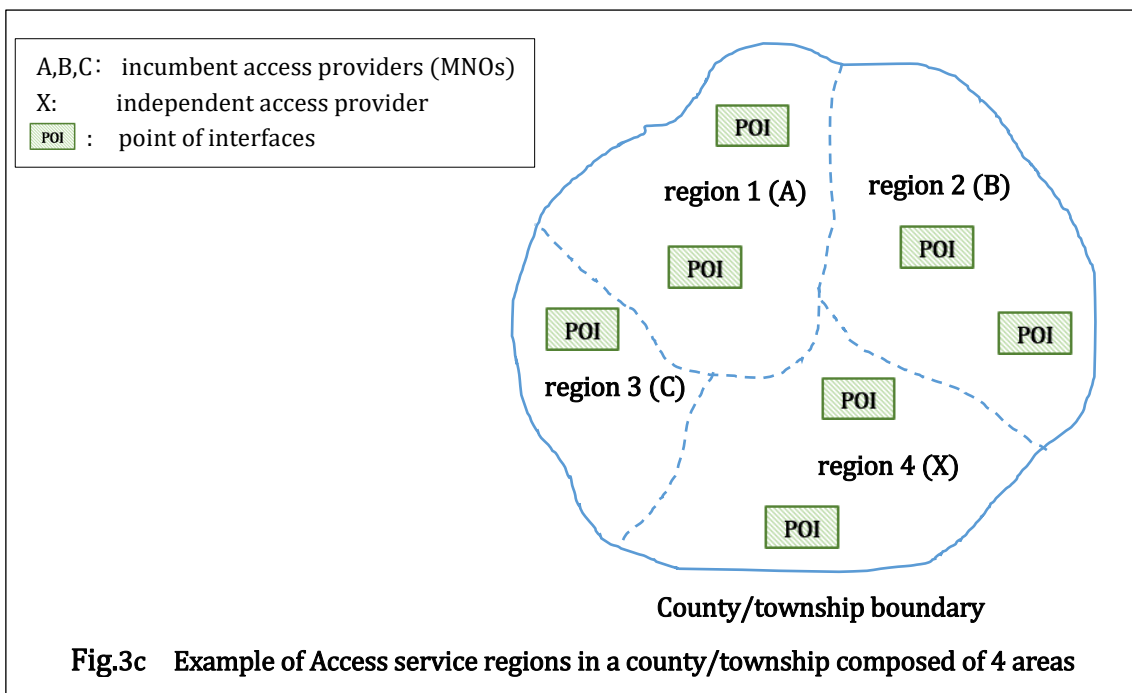
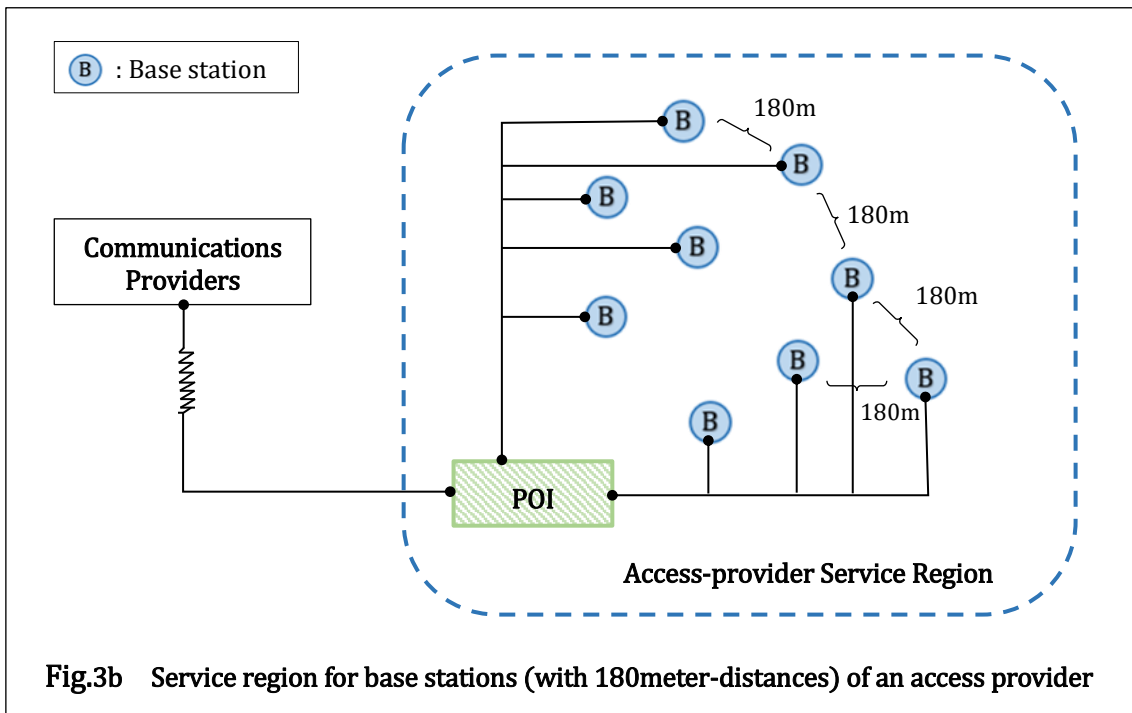
b. interface formats for data transmission at POI

must observe national/international standards

3. hand-over operation with other APs

follows the instruction of CP with CP's handset-location databases





C. Service rules

1. must treat CPs and consumers equally, no discrimination
2. service stoppage due to accidents:
penalties imposed on AP by RB

3. congestions:
not responsible (handled by CP)

D. Revenues and expenditures

1. annual revenue
paid by CPs through RB as the fee of using base stations deployed in the region
2. expenditures
fees to be paid to RB annually (→VI.D.2)

IV. Communications Providers (CP)

A. Business principles

commercial (profit-making) and nationwide operation
free service provision and free price setting
free entry/exit, free MA

B. Business activities

1. provide communications services to consumers
by using spectrum channels
need to prepare devices and systems equipment
including handsets, routers, switches, optical fibers, databases
2. spectrum channels
to be obtained through auction (if necessary) from RB for each region
3. use of base stations to be provided by AP

C. Service rules

1. no regional or inter-regional price discrimination
2. no universal-service obligation
3. for service stoppage of access channels:
receives compensation from AP through RB
4. for congestion of access channels:
CP will be responsible

D. Revenues and expenditures

1. revenues
compensation for communications services
to receive from consumers
2. expenditures
 - a. the fee of using spectrum channels to be paid to RB (if necessary)
 - b. the fee of using base stations
to be paid to AP (→VI.B)

V. The Regulation Body (RB)

A. Regulation principles

1. organization

public organization, no profit seeking

an independent government agency or a public corporation

2. objectives

to work for the benefit of the consumers as a whole

regulation of APs and CPs

to intermediate financial transactions between APs and CPs

to obtain the rent from the spectrum resources

(secondary objective) to achieve universal service goal

B. Provision of the business framework for APs and CPs

1. specification of service regions

possibly from coarser to finer divisions as time goes on (Fig.5a)

ex. coarse division: 20-50 regions (6-1.4 mill pops each) in Japan

assignment of 5G spectrum channels

determination of the locations of POIs in each region

5G stage	division of regions									type
beginning	R1		R2			.....	RM			coarse
intermediate	R11	R12	R21	R22	R23	.....	RM1	RM2	RM3	medium
long-term						.....				fine

Note: AP is obliged to declare a supply price (*S*) for each division

Fig.5a Example of Region Division

2. assigning a franchise right to APs in each region

once-and-for-all auction of franchise right at the beginning of 5G

other business with APs (→VLD)

3. supply of spectrum channels to CPs

through periodic auctions, if necessary

C. Regulation of the behavior of CPs and APs

1. obligations imposed on CPs
 - a. no discrimination of consumers regarding service contents or prices within or between service regions
 - b. publication of the detailed contents of each service to consumers
 - c. publication of monthly reports of services and accounting details
2. obligation imposed on APs
 - a. no discrimination of CPs in providing wireless access services
 - b. publication of monthly reports of accounting details as specified by RB
3. no regulation on APs regarding the deployment speed of base stations
4. no regulation on CPs or APs other than those listed above and including
 - a. MA of, or by, other providers within, or outside of the industry, and
 - b. cross subsidization, regional or organizational, by CPs and APs
might help APs and CPs at the initial deployment of 5G
distortions from cross subsidization will be eliminated in the long-run

D. Revenues and expenditures

1. receive the station revenue tax from APs (→VI.B.2)
2. receive the annual franchise holding fees from APs (→VI.D.2)
3. receive the station usage fees from CPs and pay them to APs (→III.D.1)
4. receive the fee of using spectrum channels from CPs (→IV.D.2a)
5. cost of RB operations to be charged according to a predetermined scheme

VI. Financial and Long-term Matters

A. Matters to be taken into account:

1. to encourage entrances of AP and to accelerate deployment of stations by AP (#1)
2. to prevent evils of monopoly in the AP business (#2)
3. to consider the possibility of whether 5G spectrum becomes scarce or otherwise (#3)
4. to have RB acquire the spectrum rent, if any (#4)
5. short- and long-run competition in the CP business (#5)
6. long-run competition in the AP business (i.e., to prevent APs from obtaining monopoly profits in the long-run) (#6)

B. Notations (for each region, unless stated otherwise; # indicates “policy variables”)

$N^{\#}$: the target number of 5G base stations to be deployed

may be set to be (population)/(population density) for each region

p : the fee for using a base station (to be set by AP)

d : the proportion of N for which 5G stations are deployed ($0 \leq d \leq 1$)

P : the total fee for the base stations in the region ($= p * d * N$)

- m : the number of CPs operating in the region
- T : the station tax
- $t^\#$: the station tax rate (common to all regions)
- S : the supply price of yielding (i.e., giving up) the franchise right by the AP together with the base station facilities and other objects sunk to the franchise
- F : the franchise holding fee ($= f * S$)
- $f^\#$: the franchise holding fee rate (common to all regions)

C. Initial and current matters of AP

1. initial auction of the franchise right (#2, partly)
 - bidding on the station usage fee p (reverse auction)
 - winner becomes the AP of the region
 - AP may lower, but may not raise, p after auction (#2)
2. revenues to AP
 - CPs operating in the region pay to AP the station usage fee $(d * P)/m$
3. the station tax on AP (#1)
 - AP pays the station tax $T = t * P$ to RB (note that T is independent of d)

D. Long-run obligation of AP

1. to provide (i.e. reveal) the supply price S of the franchise right at the beginning of a period
2. to pay the franchise holding fee F to RB for each period
3. if there is a new provider willing to pay S for the region, then the franchise right shall be transferred to such a provider within the 6-months period (#2, partly; #6)

E. Implications of the scheme (EMM: extended market mechanism, Oniki (2010))

1. to introduce competition to the 'market' of the franchise right
2. the franchise fee rate (f) may be considered as the 'controller' of the demand and the supply of the 'franchise-right market' (similar to the central bank rate being the 'controller' of the aggregate demand and the supply)

VII. The Initial Stage of 5G

A. 4G/LTE MNOs and MVNOs

1. regulations
 - basically unchanged from the current one
2. transition from 4G
 - MNOs may enter into 5G business by establishing their own "departments" for CP and AP operations
 - MVNOs may enter as CPs

B. New regulations to be imposed to MNOs

must provide 4G fallback services to CPs at the rate of the one's own 4G operation,
if requested

C. Possible “mistakes” at the initial auction by APs

1. p is too high:

AP will obtain excess profits in the short-run, but
will be forced to lower p in the long-run (#2)

2. p is too low:

the AP business (entry) may fail, and
may have to return the franchise right to RB for another auction

D. Comparison of the vertical separation in 5G and the vertical integration in 5G as extended from 4G

1. accounting and financial transactions

very different

but similar in effect through the allowance of vertical and regional cross
subsidization

2. technical operations

similar except that APs must observe the national or international standards in
providing API at each POI

3. 5G deployment

a. vertically integrated MNO

the deployment speed in each region would be determined based on the
forecast of the demand for 5G made by MNO

b. vertical separation

similar to the above except that the forecast will be made by the AP of each
region

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