



# Regulatory legacy, VoIP adoption and investments, and policy challenges

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*COST 605 meeting, Seville, April 3, 2008*



# Structure of presentation

1. Motivation and focus
2. Some background on VoIP
3. Model and assumptions
4. Case I: exogenous customer groups
5. Case II: migration from PSTN to VoIP
6. Investment incentives
7. Conclusion



## 1. Motivation and focus

- Emergence of IP-based telephony
  - VoIP
  - VoB
- Will incumbents opt for all-IP networks? Will they eventually abandon PSTN?
  - Balance of old and new technologies
  - Distinguish between backbone and edges
- Changing role for regulation
  - Inheritance from PSTN world
  - Need for deregulation/re-regulation?



## 1. Motivation and focus

- VoIP types covered by our paper
  - VoIP introduced by traditional operators (incumbents)
  - VoIP introduced by cable operators
  - VoIP introduced by LLU entrants
- Partly applies to other VoIP types
  - e.g. PC-based telephony over the Internet
- Focus on VoIP in a world where PSTN still exists
  - Relationship between old and new
  - Transition from old to new



## 1. Motivation and focus

- Current paper

- Regulation of terminating access prices
  - Theoretical base model: de Bijl and Peitz (2006)
- In the case of unbundling, we abstract from regulatory issues concerning LLU prices
- Investment incentives



## 2. Some Background on VoIP

- PSTN (public switched telephone network)
  - Circuit-switched network
  - Metering according to connection time
- VoIP (voice over Internet protocol)
  - Packet-switched network
  - “Digital convergence”
  - End-user access through broadband, cable, etc.
- Penetration of high-speed (internet) access critical prerequisite for the success of VoIP



## 2. Some Background on VoIP

- Regulatory issues
  - Definition of VoIP (does the European regulatory framework apply? should it be regulated like a PSTN?)
  - Numbering
  - Universal service
  - Access regulation
- This paper: interaction between PSTN and VoIP and effects of PSTN regulation



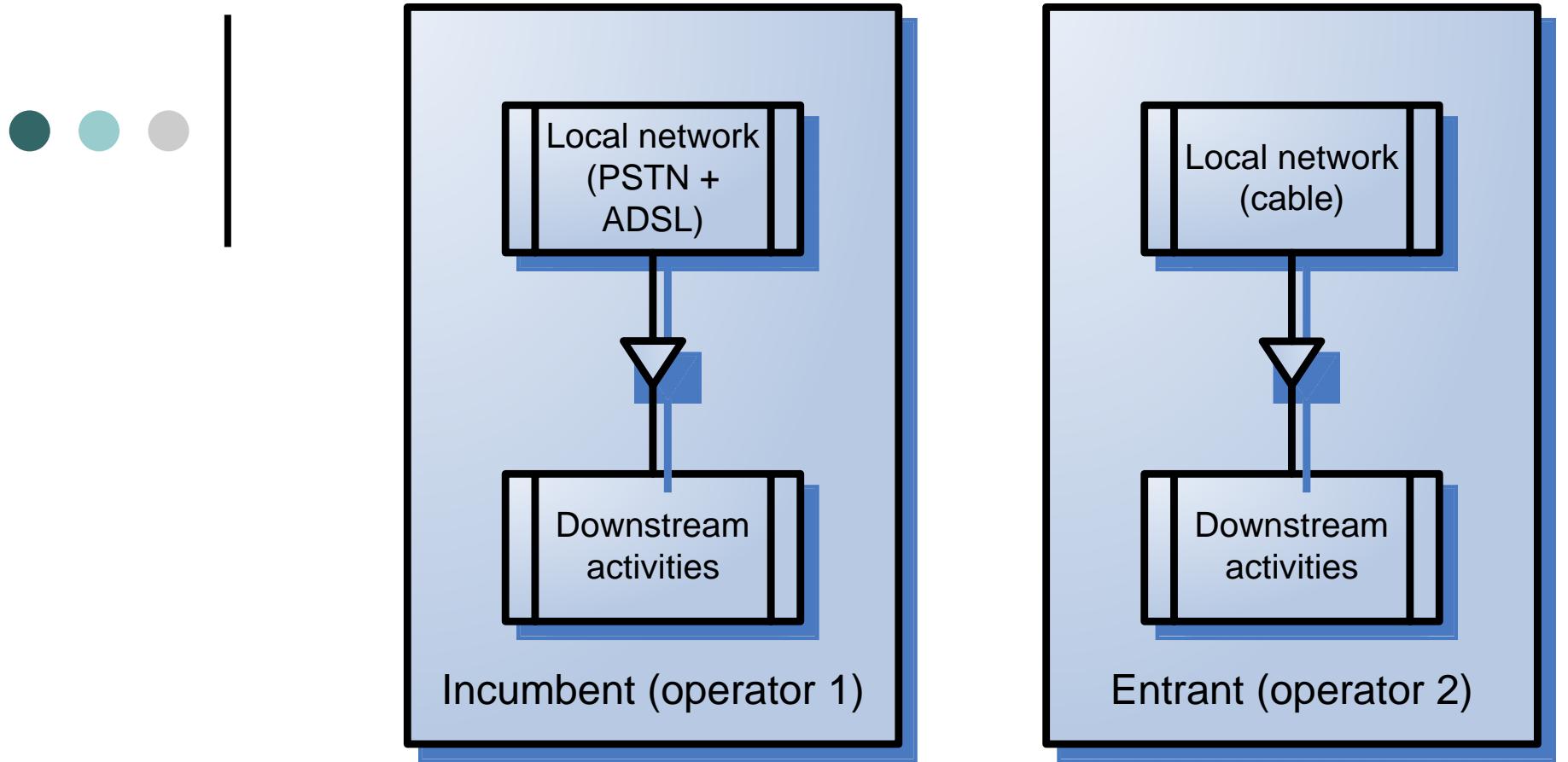
### 3. Model and assumptions

- Two operators
  - Incumbent (operator 1)
  - Entrant (operator 2)
- Only the incumbent is active in the PSTN segment
  - Providing PSTN telephony
- Both operators are active in the VoIP segment
  - Providing VoIP telephony (or some bundle)
- All networks are interconnected

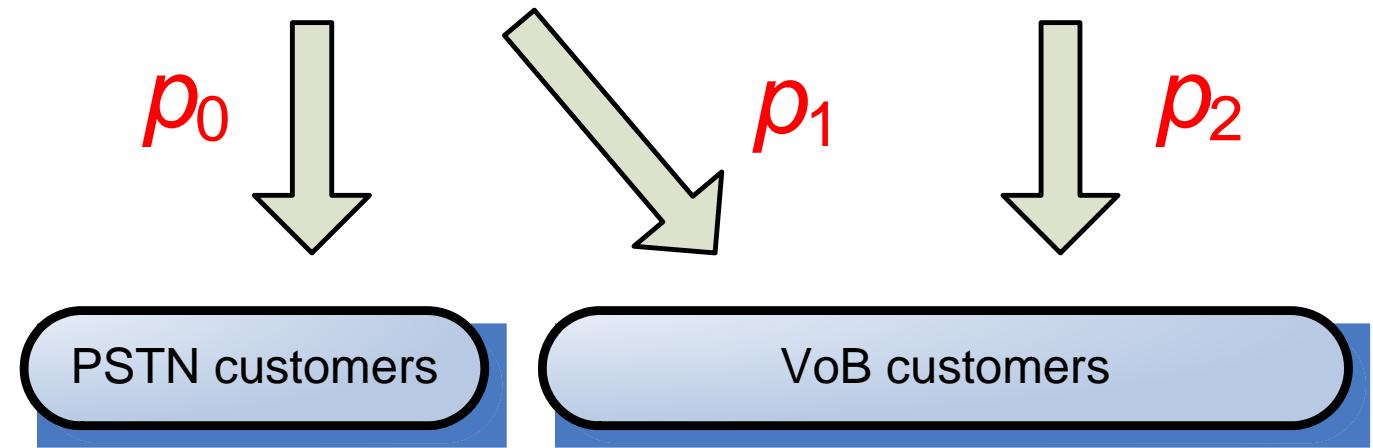


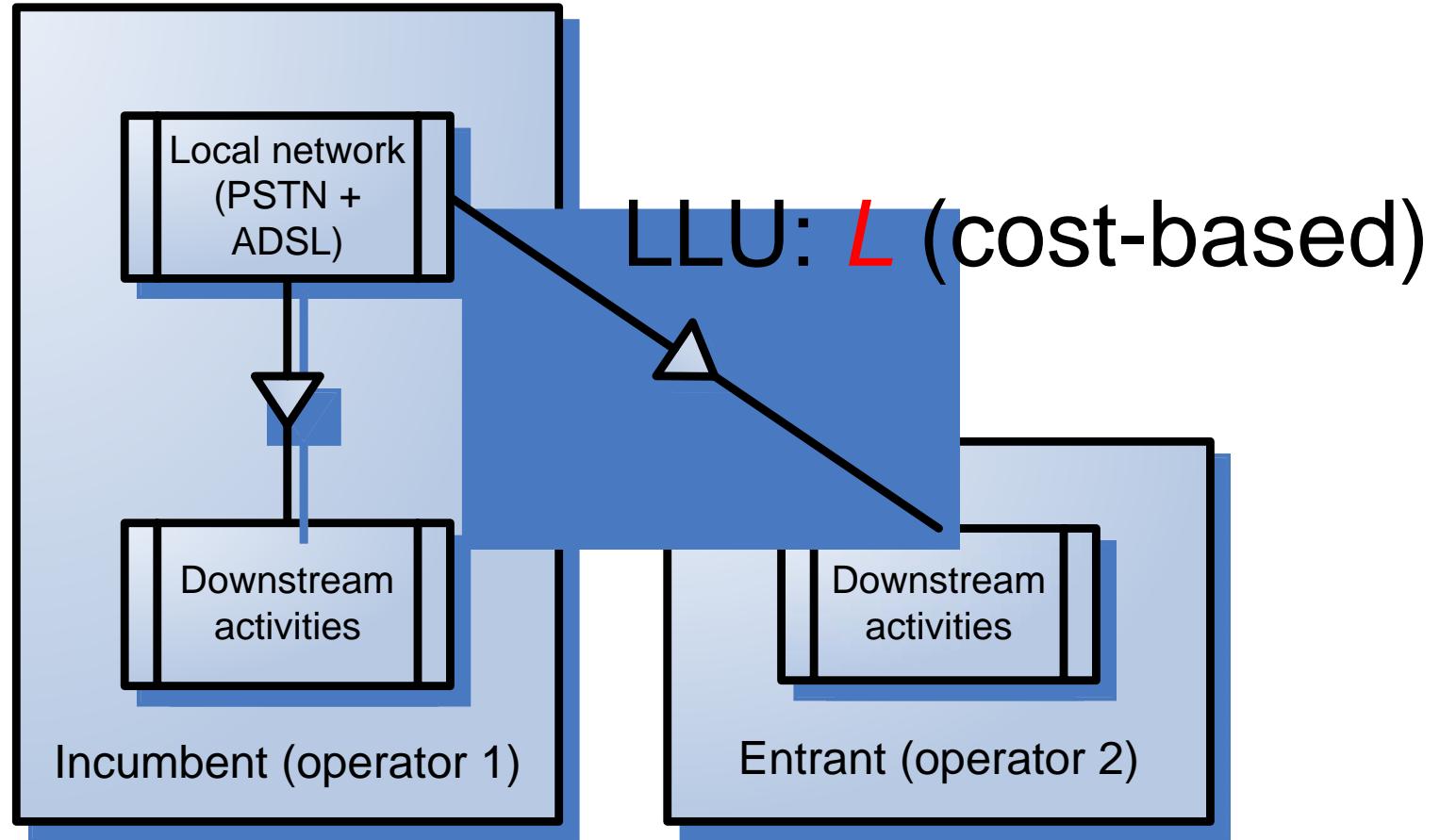
### 3. Model and assumptions

- Imperfect competition (in prices  $p_1$  and  $p_2$ ) for VoIP customers
  - Incumbent (operator 1)
  - Entrant (operator 2)
- By assuming that LLU prices are set at cost-based levels, the model applies to two types of entrant
  - Cable operator
  - LLU-based entrant (including bitstream access)

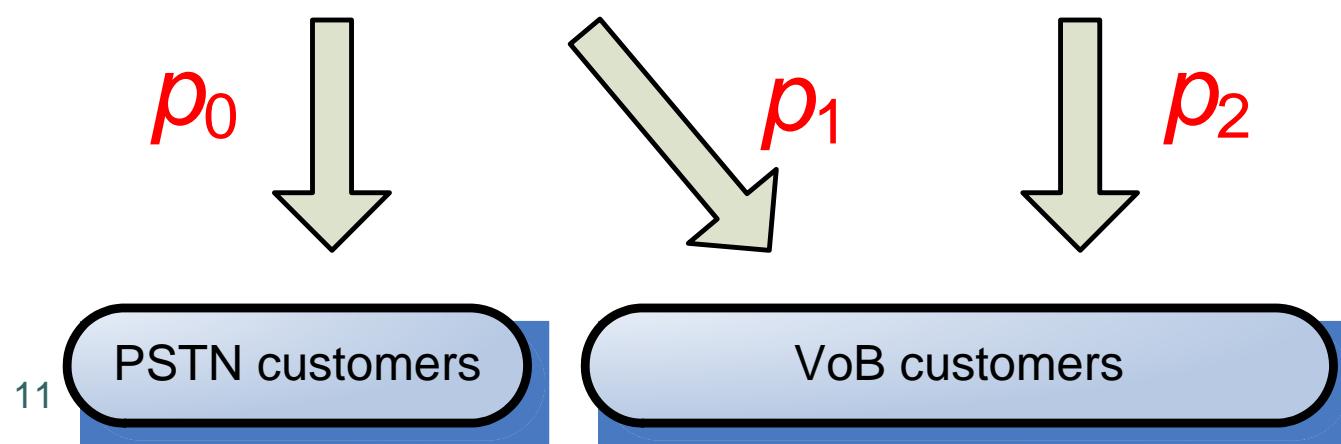


Example 1:  
Incumbent +  
cable operator





Example 2:  
Incumbent  
+ LLU  
entrant





### 3. Model and assumptions

- Terminating access: benchmark case
  - Access charge  $a > 0$  only for call termination on PSTN
  - All other traffic: bill-and-keep (access charge 0)
  - Different situations will be discussed later
- Parameter  $c$  denotes the “marginal” (i.e., traffic-dependent) cost of call termination on PSTN
  - All other costs are set at 0



### 3. Model and assumptions

- Access price  $a$  is given
  - Exogenous parameter, can be varied to see how competition is affected
  - Comparative statics: derive optimal level from a regulatory viewpoint
- PSTN retail price  $p_0$  is given
  - Exogenous parameter, can be varied to see how competition is affected
  - Comparative statics: derive...
    - ... optimal level from a regulatory viewpoint
  - Extension: set at a first stage by profit-maximizing incumbent



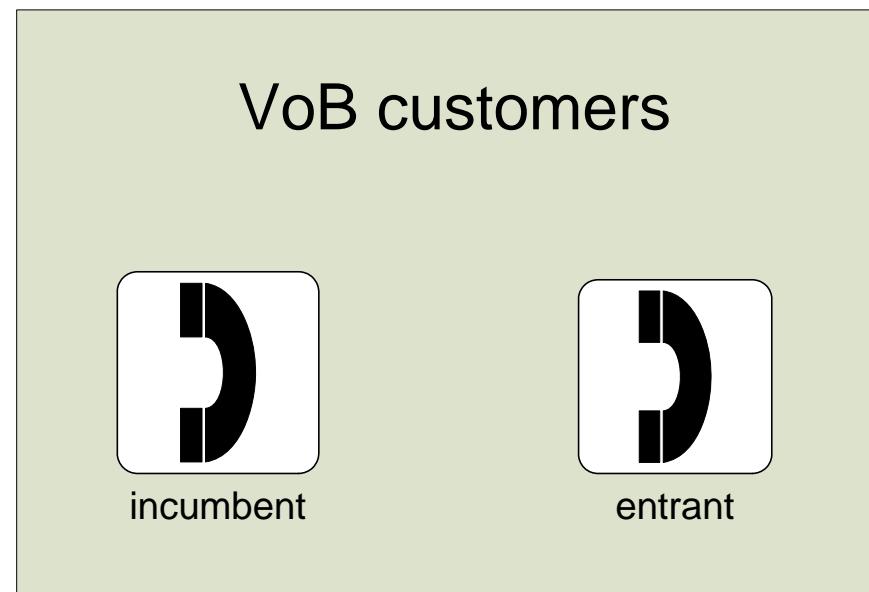
### 3. Model and assumptions

- Sizes of customer groups
  - PSTN users:  $\lambda_0$
  - VoIP users:  $\lambda$
  - Constant market size:  $\lambda_0 + \lambda = 1$
- Two cases:
  - I. Benchmark: Exogenous customer groups
  - II. Customers can choose between PSTN and VoIP



Case II: consumers  
can migrate

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### 3. Model and assumptions

- Consumers have an identical, inelastic demand for 1 unit of the good (e.g. having access to a telephone line)
- Market shares in VoIP segment are denoted by
  - $s_1(p_1, p_2)$
  - $s_2(p_1, p_2)$
- Market shares depend on:
  - Difference between  $p_1$  and  $p_2$
  - Difference in VoIP telephony qualities, showing up in utility obtained from buying from operator 1 versus operator 2
  - Horizontal differentiation parameter (Hotelling set-up)



### 3. Model and assumptions

- Calling patterns are balanced
  - This implies that the volumes of on-net and off-net calls are proportionate to market shares
  - Natural benchmark



### 3. Model and assumptions

- Incumbent's profit function:

$$\pi_1(p_1, p_2; a, p_0) = \lambda_0 (p_0 - \lambda_0 c) +$$

$$\lambda [s_1(p_1, p_2) (p_1 - \lambda_0 c) + s_2(p_1, p_2) \lambda_0 (a - c)]$$

- Entrant's profit function:

$$\pi_2(p_1, p_2; a, p_0) = \lambda s_2(p_1, p_2) (p_2 - \lambda_0 a)$$



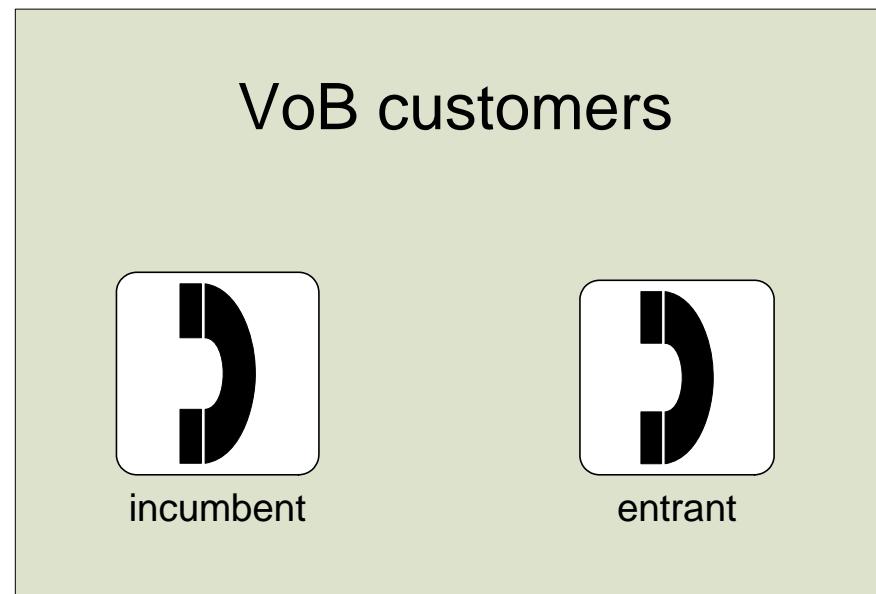
### 3. Model and assumptions

- Game in case I
  1. Variables  $a$  and  $p_0$  are given
  2. Each operator  $i$  chooses VoIP price  $p_i$  to maximize its profits,  $i = 1, 2$
  3. Consumers observe retail prices and make purchase decisions, based on utility maximization
- Game is solved by deriving Nash equilibrium  $(p_1^*, p_2^*)$ 
  - Game in case II will be somewhat different



## 4. Case I

- Customer groups are completely separate
- Sizes of customer groups ( $\lambda_0$  and  $\lambda$ ) are exogenously given
  - No migration from PSTN to VoIP



Case I: Exogenous  
customer groups



## 4. Case I

- Consider an increase in  $a$ 
  - Translates into higher retail prices  $p_1^*$  and  $p_2^*$
  - Market shares unaffected
- Intuition
  - Access price increase is completely passed on to consumers
    - Difference between  $p_1^*$  and  $p_2^*$  remains constant
  - All consumers purchase
    - Willingness to pay is sufficiently high
    - Inelastic demand for one unit of the good



## 4. Case I

- Consider an increase in  $a$ 
  - Incumbent's profits  $\pi_1$  increase
  - Entrant's profits  $\pi_2$  constant
- Interpretation
  - Only the incumbent benefits from a higher access price  $a$
  - The entrant increases its retail price  $p_2^*$  in proportion to its higher marginal cost for calls to PSTN customers



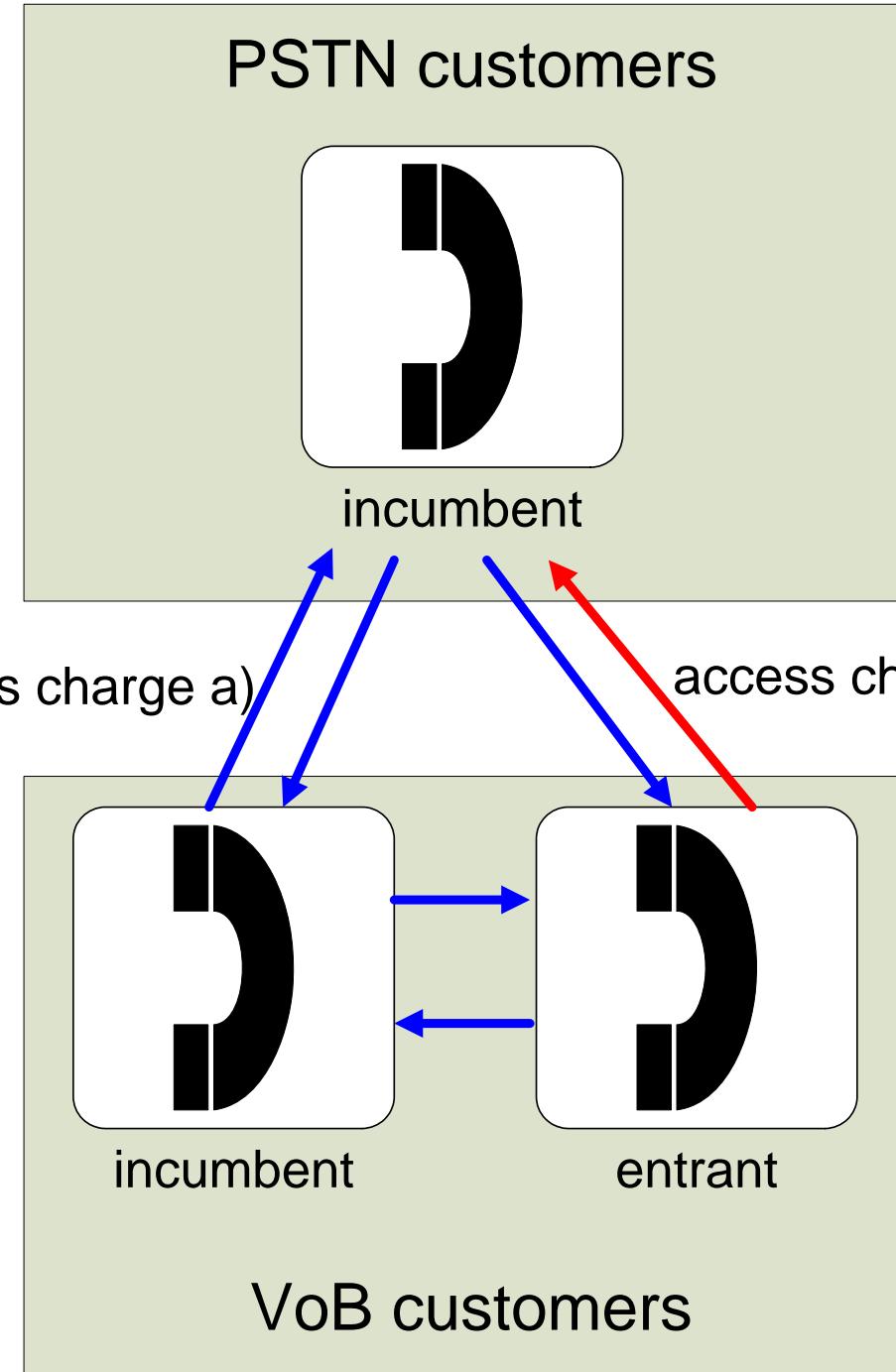
## 5. Case II

- Consumers can choose between PSTN and VoIP
- Sizes of customer groups ( $\lambda_0$  and  $\lambda$ ) are endogenously determined
  - Migration from PSTN to VoIP is endogenous...
  - ... and depends on retail prices and quality differences of PSTN and VoIP offerings



Terminating access  
payments:  
benchmark case

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## 5. Case II

- Assumption: consumers have different preferences:
  1. Uniformly distributed preferences towards PSTN versus VoIP
  2. Uniformly distributed preferences towards incumbent versus entrant



## 5. Case II

- Incumbent's profit function:

$$\pi_1(p_1, p_2; a, p_0, \underline{p}_1, \underline{p}_2) = \lambda_0 (p_0 - \lambda_0 c) +$$

$$\lambda [s_1(p_1, p_2) (p_1 - \lambda_0 c) + s_2(p_1, p_2) \lambda_0 (a - c)]$$

- Entrant's profit function:

$$\pi_2(p_1, p_2; a, p_0, \underline{p}_1, \underline{p}_2) = \lambda s_2(p_1, p_2) (p_2 - \lambda_0 a)$$

- Now  $\lambda_0 = \lambda_0(p_0, \underline{p}_1, \underline{p}_2)$  and  $\lambda = \lambda(p_0, \underline{p}_1, \underline{p}_2)$



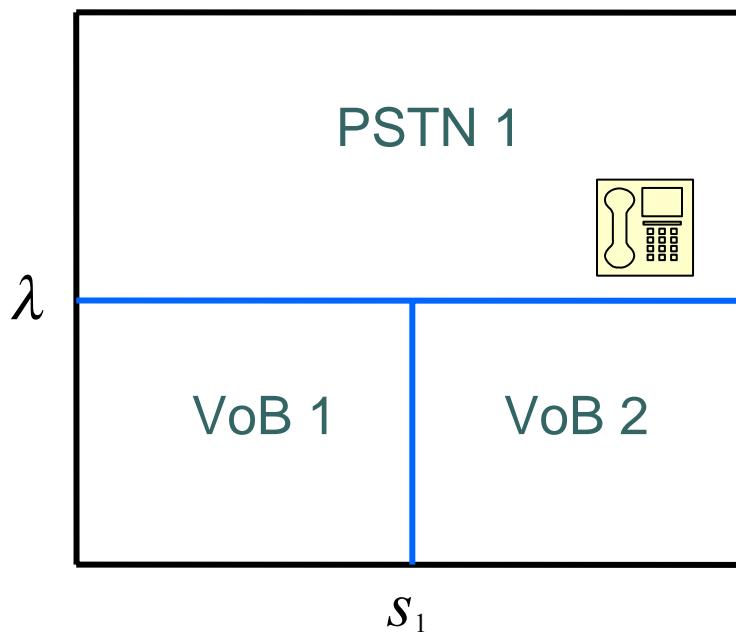
## 5. Case II

- timing of events
  1. Regulator sets  $a$  and  $p_0$
  2. Given preferences consumers choose between PSTN and VoIP. Operators simultaneously set prices  $p_1$  and  $p_2$
  3. Consumers observe  $p_1$  and  $p_2$ , and those who decided to migrate, make purchase decisions



## 5. Case II

- Representation of market shares





## 5. Case II

- Result 1a: Consider an increase in access price  $a$ 
  - VoIP prices  $p_1^*$  and  $p_2^*$  increase (at an increasing rate)
- Intuition
  - Entrant's perceived marginal cost is increased
  - Entrant increases its retail price
  - Incumbent's opportunity cost is also increased
  - Incumbent increases its retail price
  - Strategic complementarity (upward sloping best responses)
  - Repeated cost effect



## 5. Case II

- Result 1b: Consider an increase in access price  $a$ 
  - $\lambda^*$ , the customer base for VoIP in equilibrium, decreases (= less migration)
- Intuition
  - A higher PSTN access price increases entrant's marginal cost; entrant increases retail price  $p_2$
  - Incumbent's opportunity cost of attracting an additional customer increases
  - The incumbent increases its retail price  $p_1$
  - Strategic complementarity
  - Higher prices for VoIP anticipated by customers



## 5. Case II

- Result 1c: Consider an increase in access price  $a$ 
  - The entrant's profits decrease
  - The incumbent's profits initially increase and, for high levels of  $a$ , decrease



## 5. Case II

- Suppose  $a > c$  and consider an increase in PSTN price  $p_0$ 
  - VoIP prices  $p_1^*$  and  $p_2^*$  decrease
- Intuition
  - Higher  $p_0$  reduces size of PSTN segment
  - Probability that entrant's customers make calls to PSTN network decreases
  - Entrant's marginal cost is reduced; entrant sets a more aggressive retail price  $p_2$
  - Incumbent's opportunity cost is reduced
  - Incumbent set a more aggressive retail price  $p_1$
  - Strategic complementarity (upward sloping best responses)



## 5. Case II

- Suppose  $a > c$  and consider an increase in  $p_0$ 
  - $\lambda^*$ , the customer base for VoIP in equilibrium, increases
- Intuition
  - If PSTN telephony becomes more expensive, more consumers will switch to VoIP
  - This effect is magnified by the increased competition in the VoIP segment



## 5. Case II

- Suppose  $a = c$  and consider an increase in PSTN price  $p_0$ 
  - VoIP prices  $p_1^*$  and  $p_2^*$  constant
- Intuition
  - Entrant's marginal cost is not affected if size of PSTN segment decreases



## 6. Investment incentives

- Investment in VoIP infrastructure and services
  - Cannibalization effect for incumbent (substitute away from PSTN)
  - Access revenue effect
- Result: If the cannibalization effect is strong, the incumbent, integrated firm invests less than the non-integrated entrant.
- Result: If the cannibalization effect is weak, the incumbent, integrated firm may invest less than the non-integrated entrant.



## 6. Extensions

- Profit drivers

- Starting point: competition in flat rates
- This is compatible with uniform per-minute prices + constant demand for call minutes
- Prices for off-net calls from VoIP to PSTN
  - In our model, per-customer revenues from these prices are equal to revenues from flat rates
  - Comparative statics properties are preserved, however, VoIP per-minute prices for off-net calls can increase if the access price is reduced

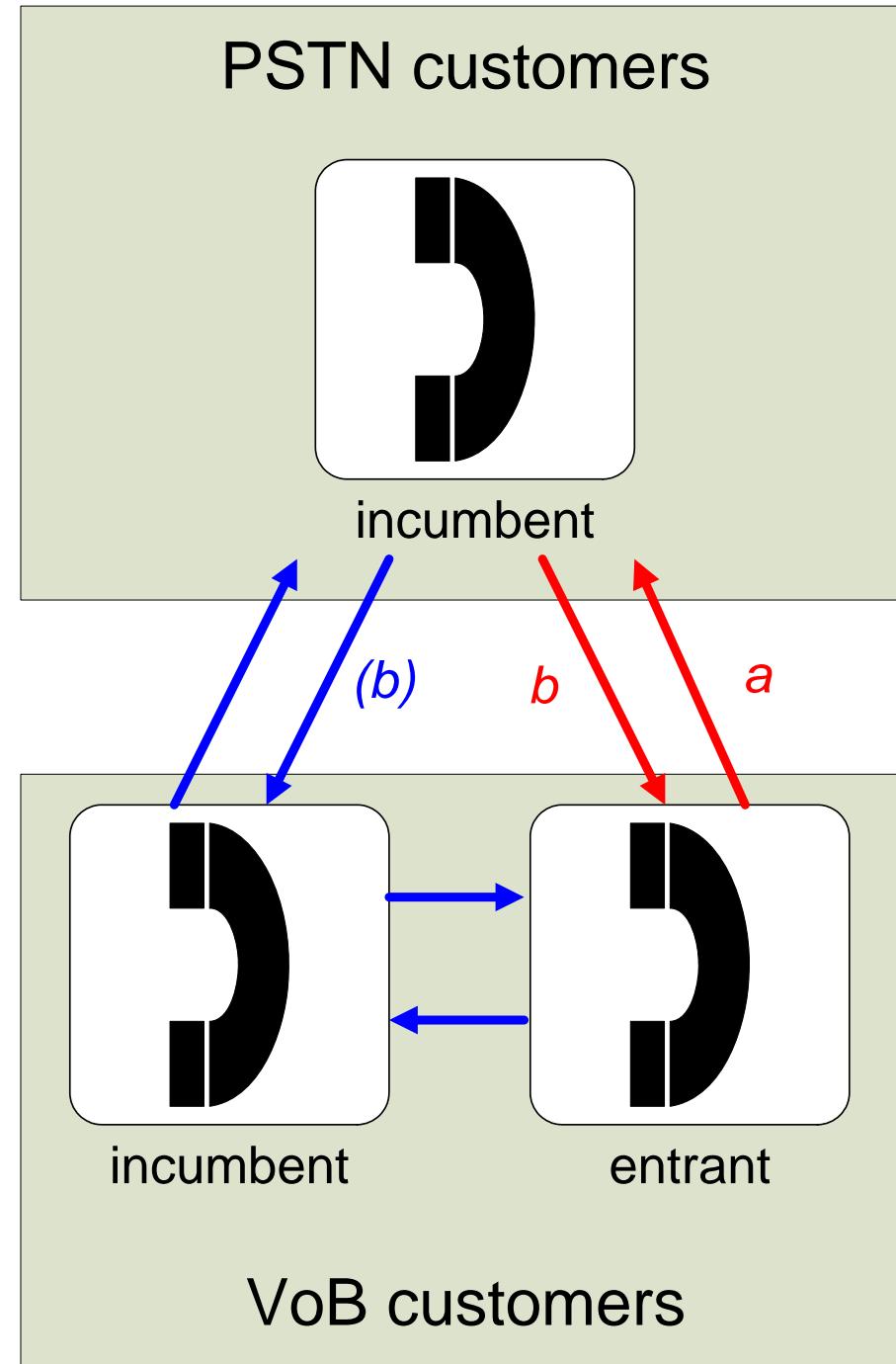


## 6. Extensions

- Terminating access
  - Add access charge  $b$  for calls originating from PSTN and terminating on VoIP networks
  - Describes some of the actual VoIP services on offer
  - Same qualitative results for  $b < a$



Terminating access  
payments:  
alternative case





## 6. Extensions

- Endogenous setting of PSTN price  $p_0$ 
  - Although the incumbent will want to exploit PSTN customers...
  - ... it is disciplined because of the presence of the VoIP segment
- We consider two cases:
  - $p_0$  determined by a competitive fringe
  - $p_0$  set by the incumbent before VoIP prices are set



## 7. Conclusion

- A first analysis of role of termination charges
  - Alternative scenarios can be explored easily with this set-up
- Regulation of access prices
  - Asymmetries between PSTN and VoIP
- Regulation of LLU prices
  - Effect on migration to VoIP?
- Investments in quality of PSTN and VoIP
  - Depending on regulatory variables
- Alternative pricing structures