Motivation

- The volume of mobile data traffic is increasing all the time rapidly
- The growth is raising concerns about the sufficiency of capacity in networks
- Various capacity sharing technologies under research would use network resources more efficiently
- These technologies will affect the value networks in the Internet and change market dynamics
Capacity sharing on different layers

- Session Initiation Protocol (SIP)
- Multipath RTP (MPRTP)
- Multipath TCP (MPTCP)
- Host Identity Protocol (HIP)
- Mobile IP (MIP)
- Dynamic spectrum management (DSM)
- Cognitive radio (CR)
Objectives

- Envision evolutions paths driven by capacity sharing technologies
  - Operator centric scenario
    - MNOs make the capacity sharing decisions
    - Dynamic spectrum management
    - Driven by reduced transaction costs
  - End-user centric scenario
    - End users make the capacity sharing decisions
    - Multipath protocols
    - Driven by reduced switching costs
- Compare and evaluate their impact on mobile access competition
- Novel way of modeling the competition
Operator centric scenario
Transaction costs

<table>
<thead>
<tr>
<th>FACTORS OF PRODUCTION</th>
<th>PRODUCTION PROCESS</th>
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<tbody>
<tr>
<td></td>
<td>Pre-production</td>
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<tr>
<td>Physical and financial capital</td>
<td>Asset specificity</td>
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<td>Human capital</td>
<td>Information costs</td>
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<tr>
<td>Work intensity</td>
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</table>
Operator centric scenario

TRANSACTION COSTS

- Bandwidth leasing
- Inter-operator spectrum sharing
- Database spectrum sharing

EVOLUTION PHASE

- Asset specificity
  - Information costs
  - Agency costs
  - Coordination costs
  - Shirking costs
  - Measurement of output
- Spectrum shared access technologies
- Spectrum database deployment

LEASING TIME

- From years to months
- From months to days
- From days to hours

High cost
- Medium cost

Sensing technologies (e.g., SDR)

Coordination costs
- Shirking costs
- Measurement of output
- Dynamic spectrum sharing

COORDINATION COSTS

Measurement of output

A!
End-user centric scenario
Switching costs

- **Financial switching costs**: Benefit loss, onetime outlays
- **Procedural switching costs**: Evaluation and learning effort, risk
- **Relational switching costs**: Personal relationship loss, brand loss

T.A. Burnham, J.K Frels & V. Mahajan
"Consumer switching costs: a typology, antecedents and consequences"
End-user centric scenario

Switching through subscription

- Financial costs
  - Loss of discounts
  - Contract penalties or lost balance
  - Subscription fee

- Procedural costs
  - Subscription settlement
  - Change of the SIM card and setup
  - Uncertainty about the quality of the new provider

Switching through multi-SIM device

- Procedural costs
  - Uncertainty about the price or the quality of the new provider

Switching through multipath protocol

Deployment of multi-SIM devices

Deployment of multipath protocols

Switching time
- From years to months
- From hours to minutes
- From minutes to seconds
## Scenario comparison

<table>
<thead>
<tr>
<th></th>
<th>Operator centric</th>
<th>End-user centric</th>
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<tbody>
<tr>
<td>Intensity of competition</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Required standardization effort</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Amount of regulation required for deployment</td>
<td>High</td>
<td>Low</td>
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</table>
Conclusions

- This study provides a holistic viewpoint to capacity sharing in mobile Internet in the future

- Other futures for the mobile access market also exists

- The simultaneous usage of DSM and multipath protocols remains unstudied

- MNOs need to revise their pricing schemes and service offerings to tackle higher competition
Questions?