Interconnection and Roaming

S-38.3041 Operator Business
Interconnection
Regulation

EU Relevant Markets include wholesale interconnection:
- Call origination/termination in an individual PSTN
- Transit services in the fixed PSTN
- Access and call origination in public mobile networks (often SMPs)
- Voice call termination in public mobile networks (always SMPs)

GSM call termination monopoly implies that
- regulator adjusts the termination prices according to operator size

Virtual Mobile Network Operators (VMNO) can survive if
- they get access capacity from MNOs (SMP decisions if necessary)
- their call termination prices do not need to be cost-oriented

Removing interconnection regulation would rapidly consolidate a mobile market
Interconnection
Business interfaces in Internet

- Business interfaces are technically managed via announcements and withdrawals of destination routes (e.g. Border Gateway Protocol)
- Three types of agreement
  - direct bilateral peering: non-transitive traffic exchanged without payment
  - bilateral peering through NAP (matchmaker -> bandwidth broker)
  - true transit traffic involving charging (typically per volume)
- Optimal business choice between peering and transit?

Source: Courcoubetis, Weber, 2003
Interconnection

Charging schemes

• Calling-party’s network pays (CPNP)
  – calling operator pays to called operator for call termination (e.g. telephony)
  – terminating operator is a de-facto monopolist ⇒ high termination charges
  – lock-in creates an opportunity for disruptive technologies such as IP telephony

• Sender Keep All (SKA, Bill-and-keep)
  – appears as peering agreements in Internet
  – network effect ⇒ discouraging to big operators ⇒ cost sharing
    e.g. facility-based interconnection cost charging ⇒ equal customer prices

• Revenue sharing
  – typically new entrant pays to incumbent (e.g. content provider to operator)
  – simple but potentially anti-competitive

• Interconnect charges based on retail prices
  – retail prices sometimes used as reference for inter-operator discounts
  – sometimes enforced by regulator

Source: Courcoubetis, Weber, 2003
Interconnection
Case Finland, April 2004

• Impact of regulator’s threat (Significant Market Power identification for mobile operators) on termination prices for GSM mobile-to-mobile calls
  – Sonera Mobile 9c/min (earlier 12,78c/min)
  – Elisa Mobile 10c/min (earlier 13,12c/min)
  – Finnet/DNA 11c/min

• National ISP interconnection is handled via FICIX ry
  – Non-profit organization (membership and port fees only)
  – No transit traffic allowed
  – Bilateral agreements required but without charging settlements
Roaming

Regulation

EU Relevant Markets include wholesale roaming:
  • Wholesale national market for international roaming on public mobile

EU is currently (2006) adding pressure to roaming prices
  • proposal to enforce retails price caps!

National regulators have difficulty in guiding international roaming prices because costs come from abroad

Internet-based access-independent approaches of solving the roaming problem (e.g. Voice-over-Internet by Skype) are likely to push roaming prices down
Mobile Roaming Relationships

- Separation of service and network operations
- Wholesale\text{\_\text{National}}: between service operator (SO) or MVNO with the national network operator (NO)
- Wholesale\text{\_\text{International}}: between NOs (home and visited) which is typically international in nature.
Importance of Roaming

- 10-15% of total revenue of mobile operators
- Traditional customers: business
- Number of private customers increasing
- International roaming market not yet matured
## Roaming Financials

### Revenue Forecast

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>$15,973</td>
<td>$16,546</td>
<td>$465</td>
<td>$1,670</td>
<td>$16,438</td>
<td>$18,216</td>
<td>$99,046</td>
<td>$137,038</td>
<td>17%</td>
<td>13%</td>
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<tr>
<td>North America</td>
<td>1,011</td>
<td>1,543</td>
<td>68</td>
<td>1,513</td>
<td>1,079</td>
<td>3,057</td>
<td>80,881</td>
<td>168,255</td>
<td>1%</td>
<td>2%</td>
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<tr>
<td>Asia Pacific</td>
<td>1,211</td>
<td>1,404</td>
<td>65</td>
<td>887</td>
<td>1,276</td>
<td>2,291</td>
<td>96,877</td>
<td>151,893</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>South America</td>
<td>175</td>
<td>229</td>
<td>47</td>
<td>400</td>
<td>221</td>
<td>629</td>
<td>17,491</td>
<td>27,424</td>
<td>1%</td>
<td>2%</td>
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<tr>
<td>Total</td>
<td>$18,370</td>
<td>$19,723</td>
<td>$644</td>
<td>$4,470</td>
<td>$19,014</td>
<td>$24,192</td>
<td>$294,294</td>
<td>$484,609</td>
<td>6%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Source: April 2002 IDC International Roaming White Paper, entitled “How Important Is International Roaming to Wireless Network Migration?”

Roaming is currently
- c. 2% of mobile operator’s traffic
- c. 10-15% of mobile operator’s revenue
### Roaming Financials

#### Revenue and cost break-down - Generic CDMA operator

<table>
<thead>
<tr>
<th>Description</th>
<th>Revenue FYE</th>
<th>Expenses FYE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue - Outbound</strong></td>
<td></td>
<td><strong>Cost of Service</strong></td>
</tr>
<tr>
<td>Unique Subscribers</td>
<td>35,000</td>
<td><em>Inter-Operator Tariff - Outbound Roaming</em> $5,250,000</td>
</tr>
<tr>
<td>Avg. # of Visits per Year</td>
<td>2</td>
<td><em>Network Cost per MOU - Inbound Roaming</em> $45,000</td>
</tr>
<tr>
<td>Avg. # of Days per Visit</td>
<td>5</td>
<td><em>Signaling</em></td>
</tr>
<tr>
<td>Avg. # of Calls per Day</td>
<td>5</td>
<td>Rental of Lease Line for Frame Relay $12,000</td>
</tr>
<tr>
<td>Avg. # of Minutes per Call</td>
<td>3</td>
<td>3rd Party Processing/Routing Service $43,750</td>
</tr>
<tr>
<td>Avg. Price per Minute</td>
<td>$2.00</td>
<td><strong>Total Signaling Cost</strong></td>
</tr>
<tr>
<td><strong>Subtotal - Outbound Revenue</strong></td>
<td>$10,500,000</td>
<td>$55,750</td>
</tr>
<tr>
<td><strong>Revenue - Inbound</strong></td>
<td></td>
<td><strong>Financial Settlement</strong></td>
</tr>
<tr>
<td>Unique Subscribers</td>
<td>15,000</td>
<td><em>3rd Party Message Processing</em> $28,000</td>
</tr>
<tr>
<td>Avg. # of Visits per Year</td>
<td>2</td>
<td><em>CIBER/CIBERNET License Fee</em> $87,188</td>
</tr>
<tr>
<td>Avg. # of Days per Visit</td>
<td>5</td>
<td><strong>Total Financial Settlement Cost</strong></td>
</tr>
<tr>
<td>Avg. # of Calls per Day</td>
<td>5</td>
<td>$115,188</td>
</tr>
<tr>
<td>Avg. # of Minutes per Call</td>
<td>3</td>
<td><strong>Subtotal - Cost of Service</strong></td>
</tr>
<tr>
<td>Avg. Price per Minute</td>
<td>$1.00</td>
<td>$5,463,688</td>
</tr>
<tr>
<td><strong>Subtotal - Inbound Revenue</strong></td>
<td>$2,250,000</td>
<td><strong>Gross Margin</strong></td>
</tr>
<tr>
<td><strong>Gross Int'l Roaming Revenue</strong></td>
<td>$12,750,000</td>
<td>$6,642,813 55%</td>
</tr>
<tr>
<td>Less: Bad Debt</td>
<td>$637,500</td>
<td><strong>SG&amp;A</strong></td>
</tr>
<tr>
<td><strong>Net Int'l Roaming Revenue</strong></td>
<td>$12,112,500</td>
<td>$3,028,125 25%</td>
</tr>
</tbody>
</table>

**Note:** Estimated costs for a generic CDMA operator

- Note: most revenue is from outbound traffic
- Note: margins are high
- Note: trust is a key issue (ref. 5% bad debt)

Source: International Roaming Business Overview: Qualcomm
GPRS Roaming
Technical Architecture - Bilateral

Source: Renjish Kaleelatzicathu, 2004
GPRS Roaming
Technical Architecture – Single GRX

- Operator A
- Operator B
- Operator C
- Operator D
- Operator E
- Operator F
- Operator G

GPRS Roaming eXchange network

GRX

DNS.gprs
DNS mce.mnc.gprs
GPRS Roaming
Technical Architecture – Multiple GRXs
GPRS Roaming
Business Interfaces between Players

- Bilateral roaming agreements between GPRS operators
- Settlement of inter-operator tariffs (IOT) via clearing houses
- Transport agreements via GPRS Roaming eXchange (GRX) operators

Source: Renjish Kaleelatzicathu, 2004
GPRS Roaming

Business Model Scenarios: Bilateral, Clustered, Centralized

<table>
<thead>
<tr>
<th>Triggers\Models</th>
<th>Bilateral</th>
<th>Clustered</th>
<th>Centralized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of contracts</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Complexity of single</td>
<td>High</td>
<td>High</td>
<td>Low ?</td>
</tr>
<tr>
<td>Management structure</td>
<td>Distributed</td>
<td>Centralized</td>
<td>Centralized</td>
</tr>
<tr>
<td>Vertical bundling</td>
<td>Yes</td>
<td>Yes</td>
<td>No ?</td>
</tr>
<tr>
<td>Control of standards spec</td>
<td>GSM MoU</td>
<td>Operator</td>
<td>Non-commercial</td>
</tr>
<tr>
<td>Competition in roaming</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Price regulations</td>
<td>No</td>
<td>No</td>
<td>Yes ?</td>
</tr>
<tr>
<td>Cost per operator</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Profit opportunity</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

• Bilateral model has dominated so far
• Clustered model develops together with global operators
• Centralized model may emerge from regulatory needs
WLAN Roaming
System Architecture using RADIUS

- Authentication based on RADIUS protocol (DIAMETER)
- WLAN charging and settlement handled by Clearing House
## WLAN Roaming

Public Hotspots Globally per Location

<table>
<thead>
<tr>
<th>Location</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airports</td>
<td>75</td>
<td>200</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>650</td>
<td>700</td>
</tr>
<tr>
<td>Hotels</td>
<td>520</td>
<td>2,500</td>
<td>9,000</td>
<td>20,000</td>
<td>30,000</td>
<td>40,000</td>
<td>45,000</td>
</tr>
<tr>
<td>Retail outlets</td>
<td>320</td>
<td>12,000</td>
<td>44,000</td>
<td>60,000</td>
<td>75,000</td>
<td>85,000</td>
<td>90,000</td>
</tr>
<tr>
<td>Enterprise Guesting Areas</td>
<td>84</td>
<td>600</td>
<td>1,000</td>
<td>4,000</td>
<td>5,000</td>
<td>6,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Transportation (trains, planes)</td>
<td>84</td>
<td>600</td>
<td>1,000</td>
<td>4,000</td>
<td>5,000</td>
<td>6,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Community Hotspots</td>
<td>1</td>
<td>300</td>
<td>3,000</td>
<td>5,000</td>
<td>8,000</td>
<td>9,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Others</td>
<td>300</td>
<td>1,000</td>
<td>1,500</td>
<td>2,400</td>
<td>3,350</td>
<td>4,300</td>
<td></td>
</tr>
<tr>
<td><strong>Total number of hotspots</strong></td>
<td><strong>1,000</strong></td>
<td><strong>16,000</strong></td>
<td><strong>59,000</strong></td>
<td><strong>93,000</strong></td>
<td><strong>135,000</strong></td>
<td><strong>167,000</strong></td>
<td><strong>190,000</strong></td>
</tr>
</tbody>
</table>

Source: Gartner

Note: status per 01-Jul-2003 estimated at 10,000 of which 12,000 in South Korea
## WLAN Roaming

### Public Hotspots per Region

<table>
<thead>
<tr>
<th># of Hot Spots</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>50</td>
<td>1,000</td>
<td>5,000</td>
<td>9,400</td>
<td>17,700</td>
<td>24,000</td>
<td>28,200</td>
</tr>
<tr>
<td>Americas</td>
<td>750</td>
<td>4,000</td>
<td>18,000</td>
<td>30,000</td>
<td>45,000</td>
<td>55,000</td>
<td>62,000</td>
</tr>
<tr>
<td>Far-East</td>
<td>100</td>
<td>10,500</td>
<td>25,000</td>
<td>51,500</td>
<td>69,000</td>
<td>83,000</td>
<td>93,000</td>
</tr>
<tr>
<td>ROW</td>
<td>500</td>
<td>1,000</td>
<td>2,100</td>
<td>3,300</td>
<td>5,000</td>
<td>6,800</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>900</strong></td>
<td><strong>16,000</strong></td>
<td><strong>49,000</strong></td>
<td><strong>93,000</strong></td>
<td><strong>135,000</strong></td>
<td><strong>167,000</strong></td>
<td><strong>190,000</strong></td>
</tr>
</tbody>
</table>

**Growth Total**: 1678% 206% 90% 45% 24% 14%

**Growth Europe**: 1900% 400% 88% 88% 36% 18%

Source: IDC + various other sources

Note: Europe is catching up this year
WLAN vs. GPRS Roaming

- GPRS roaming being deployed based on home-network routing (cmp. GSM)
- WLAN roaming being deployed based on visited network routing (direct local access to Internet) ⇒ strong trust required between operators
- Roll-out of WLAN in handsets is likely to increase the use of SIM/HLR authentication for roaming
- GRX enables end-to-end quality of service (QoS) control
  - MMS uses GRX for both interconnect and roaming traffic
  - Voice-over-IP on public WLAN could use GRX for QoS
Roaming Agreements
Case: Sonera in April 2004

• International roaming coverage
  – GSM in c. 100 countries (c. 220 operators)
  – GPRS in c. 50 countries (c. 90 operators)
  – WLAN (GSM Association IR.61) in 16 countries (3500 hotspots)

• Sonera GRX service connects e.g. all Finnish mobile operators to each others and to foreign networks

• Sonera builds own public WLAN coverage in Finland
  ⇒ no national WLAN roaming agreements so far

• Unified roaming tariffs announced within Europe (11 countries, GSM voice call 0.95€/min)