Interconnection and roaming

S-38.041 Networking Business

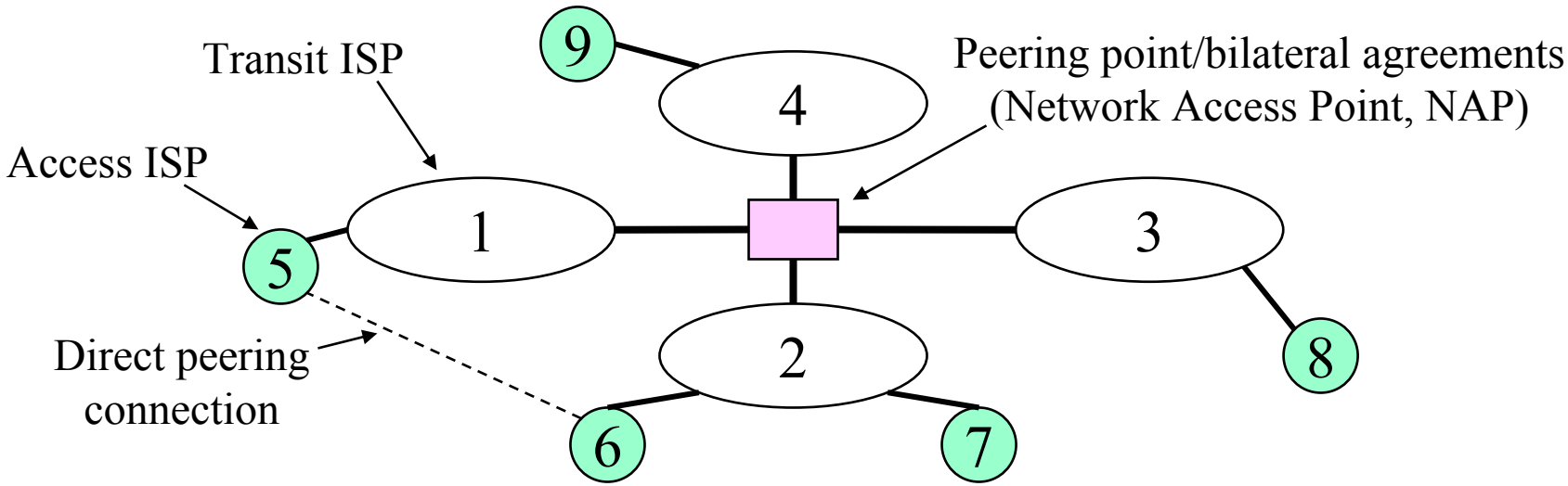
Interconnection

Network effect

- Positive network effect in communication networks
  - user level: value-add of a new user to the existing users
  - network level: value-add of a new network to the existing networks
- The essence of network effects
  - *Effect* vs. *externality*: network effect becomes an externality if the market participants fail to internalize the effect ⇒ market failure
  - *Literal* (e.g. Internet) vs. *virtual* networks (e.g. automobiles): literal networks are characterized by goods that provide physical connection between customers
  - *Direct* (e.g. fax machines) vs. *indirect* (e.g. laser printer and toner cartridges) network effects: direct effect is based on the good itself whereas indirect effect appears as complementary goods

Interconnection

Business interfaces in Internet



- Business interfaces are technically managed via accouncements and withdrawals of destination routes (e.g. Border Gateway Protocol)
- Two types of agreement
  - bilateral non-transitive peering traffic exchanged without payment
  - transitive transit traffic involving charging (typically per volume)
- In addition to matchmaker, NAP may also become a bandwidth broker
- 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
  - 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
- Forward Looking Incremental Costs (cmp. Long Run Incremental Costs)
  - produces efficient prices but may not satisfy the incumbents
- Revenue sharing
  - typically new entrant pays to incumbent
  - simple but potentially anti-competitive
- Interconnect charges based on retail prices
  - retail prices sometimes used as reference for inter-operator discounts

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 mobile-to-mobile circuit-switched 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
  - non-profit organization (membership and port fees only)
  - Two member classes: full (no peering), supporting (peering needed)

Roaming financials

Revenue Forecast

($ millions)	Intra-continental Roaming		Inter-continental Roaming		Total Roaming Revenues		Total Service Revenue		Roaming as a % of Total Revenue	
	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
Europe	$15,973	$16,546	$465	$1,670	$16,438	$18,216	$99,046	$137,038	17%	13%
North America	1,011	1,543	68	1,513	1,079	3,057	80,881	168,255	1%	2%
Asia Pacific	1,211	1,404	65	887	1,276	2,291	96,877	151,893	1%	2%
South America	175	229	47	400	221	629	17,491	27,424	1%	2%
Total	$18,370	$19,723	$644	$4,470	$19,014	$24,192	$294,294	$484,609	6%	5%

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. 10-20% of mobile operator's revenue

Roaming financials

Revenue and cost break-down - Generic CDMA operator

		FYE
Revenue - Outbound		
Unique Subscribers		35,000
Avg. # of Visits per Year		2
Avg. # of Days per Visit		5
Avg. # of Calls per Day		5
Avg. # of Minutes per Call		3
Avg. Price per Minute		$2.00
Subtotal - Outbound Revenue		$10,500,000
Revenue - Inbound		
Unique Subscribers		15,000
Avg. # of Visits per Year		2
Avg. # of Days per Visit		5
Avg. # of Calls per Day		5
Avg. # of Minutes per Call		3
Avg. Price per Minute		$1.00
Subtotal - Inbound Revenue		$2,250,000
Gross Int'l Roaming Revenue		$12,750,000
Less: Bad Debt	5%	$637,500
Net Int'l Roaming Revenue		$12,112,500

Expenses			
Cost of Service			
Inter-Operator Tariff - Outbound Roaming	$5,250,000		
Network Cost per MOU - Inbound Roaming	$45,000		
Signaling			
Rental of Lease Line for Frame Relay	$12,000		
3rd Party Processing/Routing Service	43,750		
Total Signaling Cost	$55,750		
Financial Settlement			
3rd Party Message Processing	$28,000		
CIBER/CIBERNET License Fee	$87,188		
Total Financial Settlement Cost	$115,188		
Fraud Management			
RoamX	$3,750		
Subtotal - Cost of Sevice	$5,469,688		
Gross Margin	$6,642,813	55%	
SG&A	$3,028,125	25%	
EBITDA	$3,614,688	30%	
Depreciation of Non-recurring Expenses	$33,333		
EBIT	$3,581,354	30%	

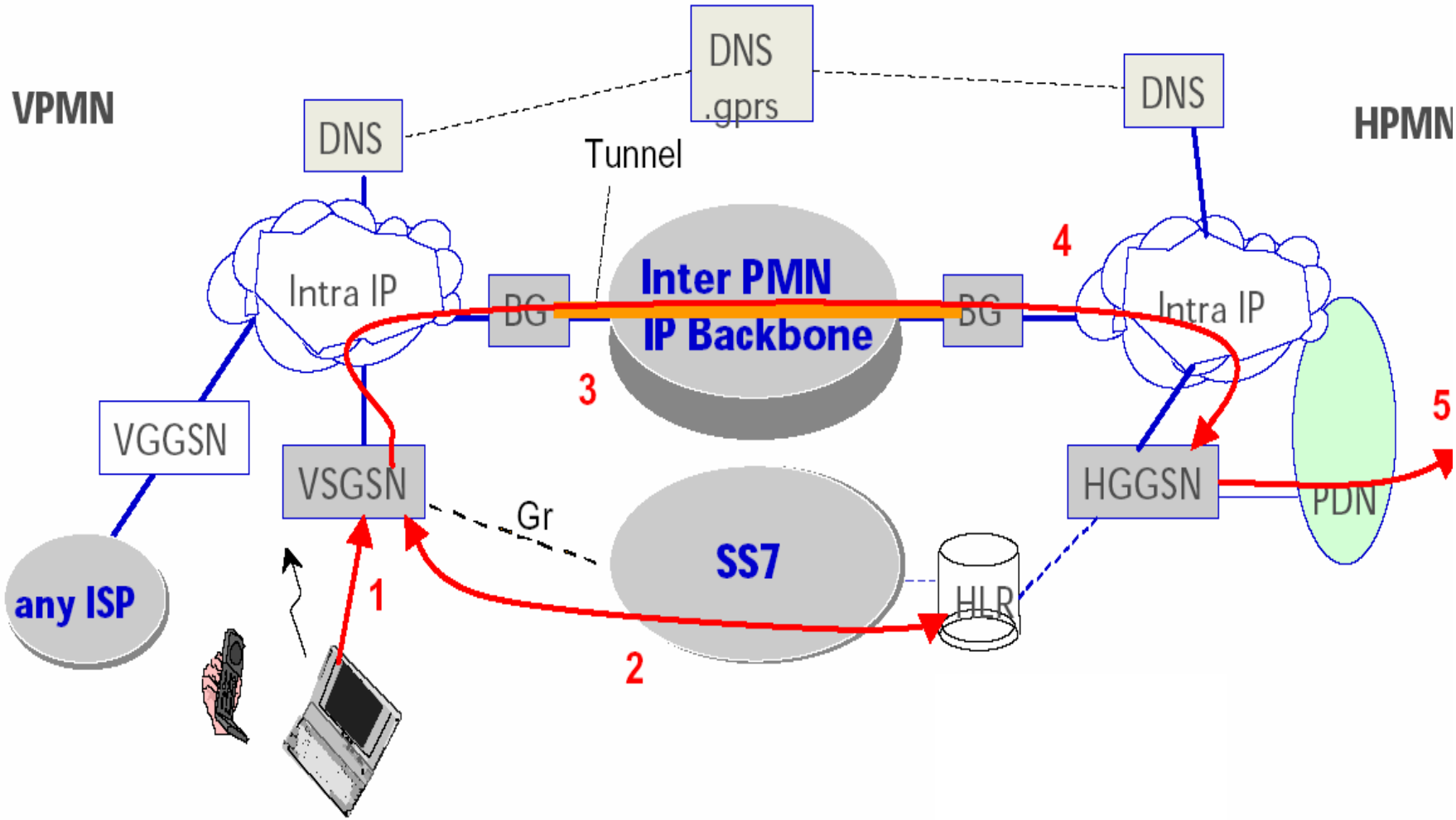
Note: Estimated costs for a generic CDMA operator

- Note: high margins
- Shared backbone (ref. GRX) costs down

Source: International Roaming Business Overview: Qualcomm

GPRS roaming

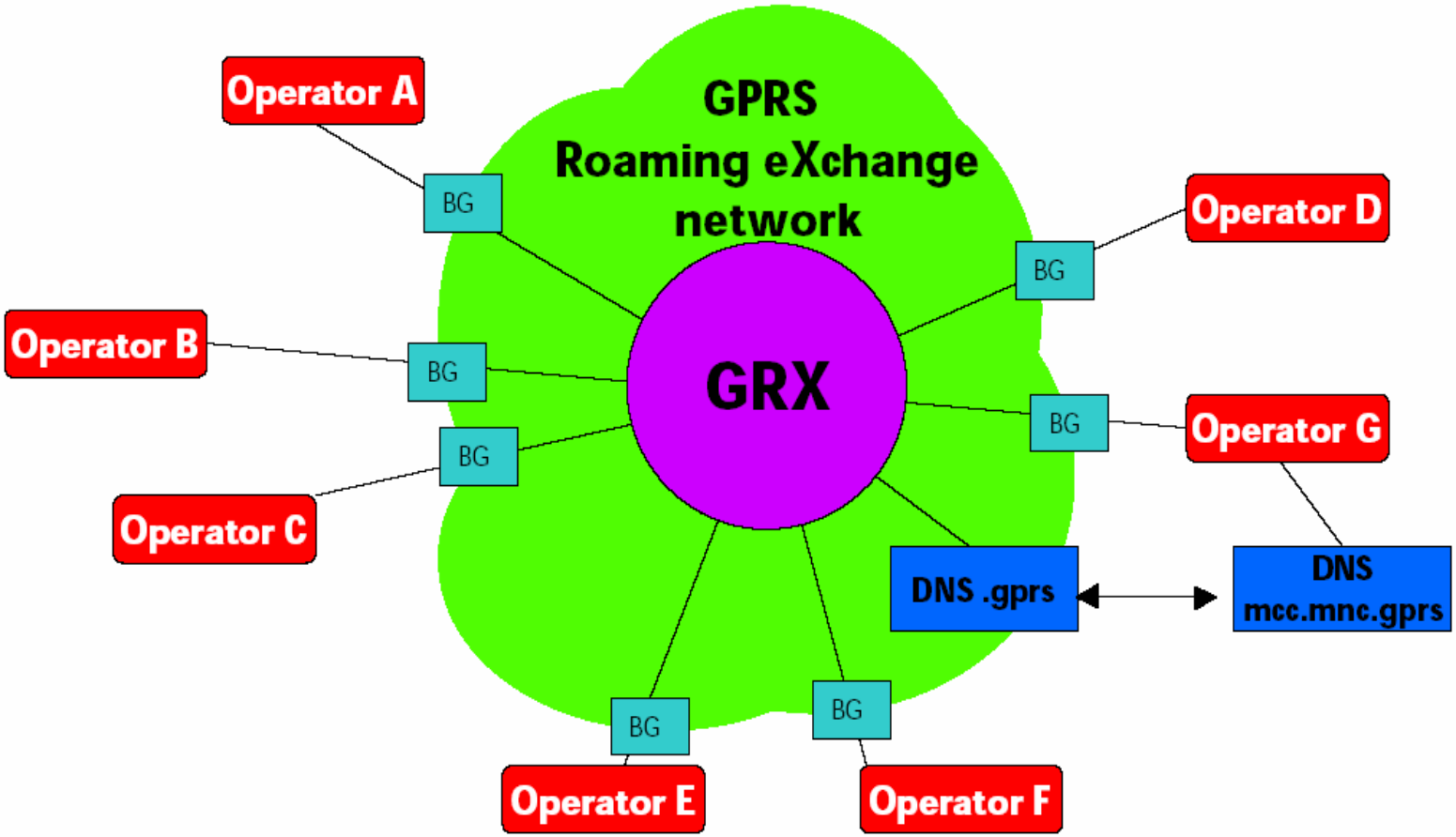
Technical architecture - bilateral



Source: Renjish Kaleelatzicathu, 2004

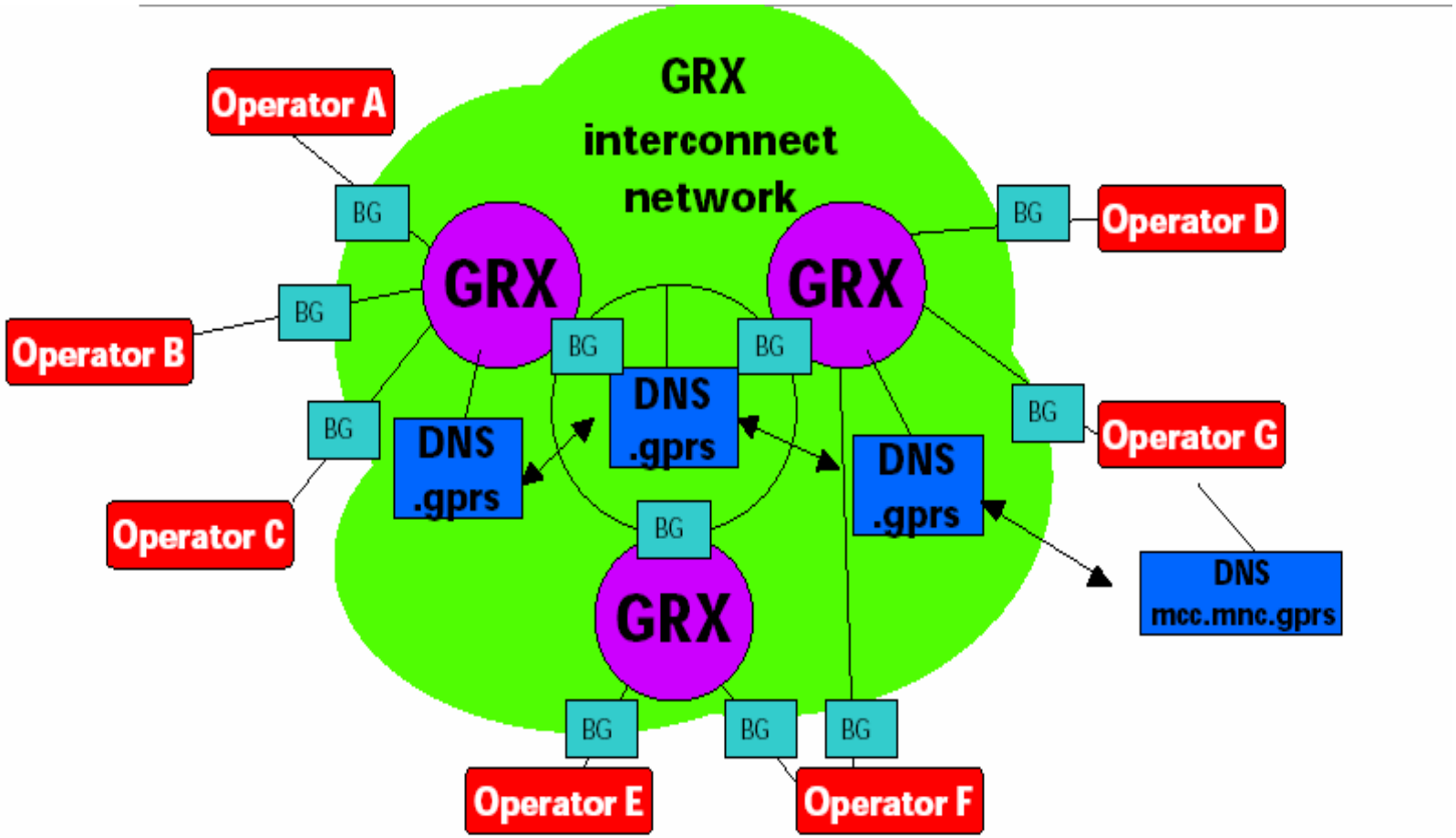
GPRS roaming

Technical architecture – single GRX



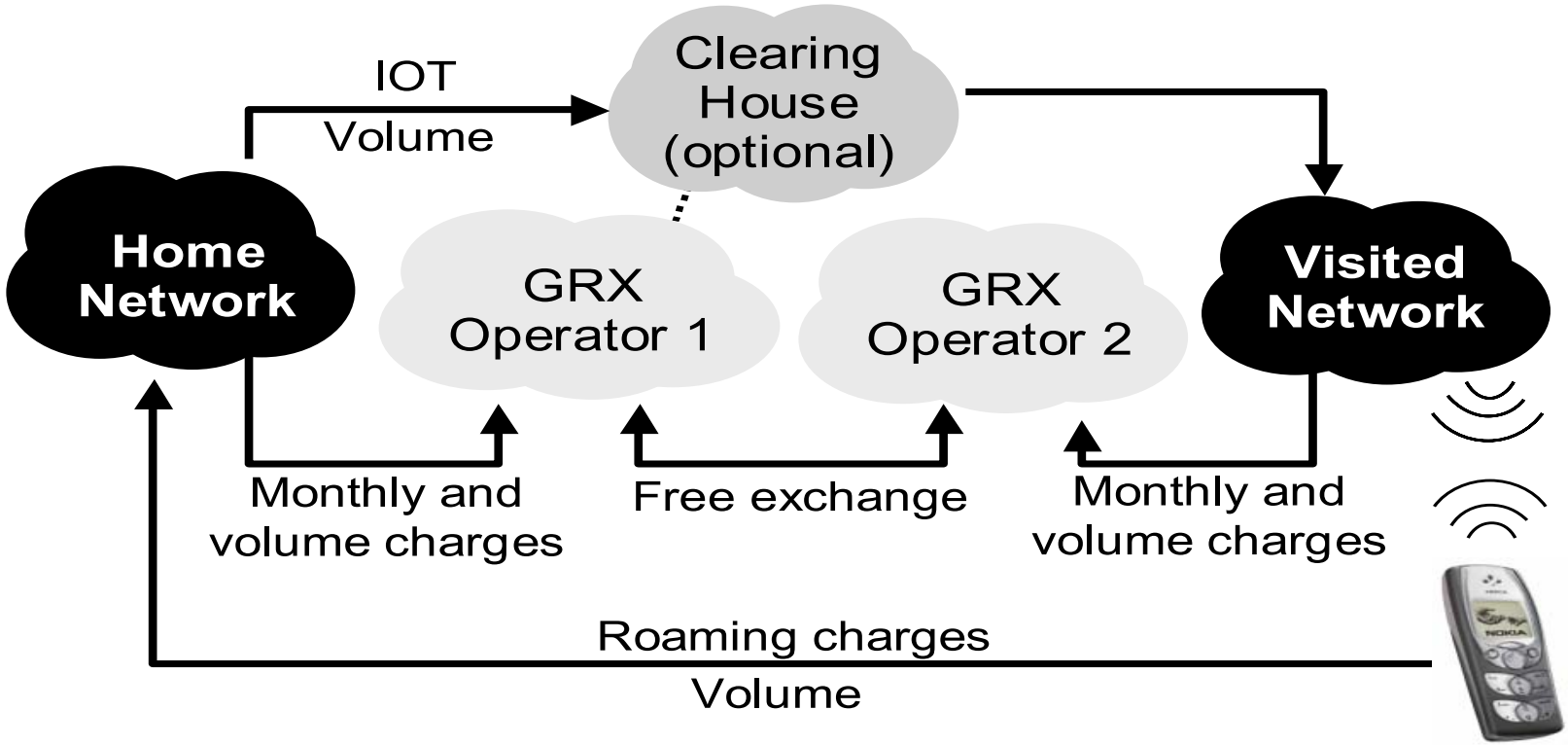
GPRS roaming

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

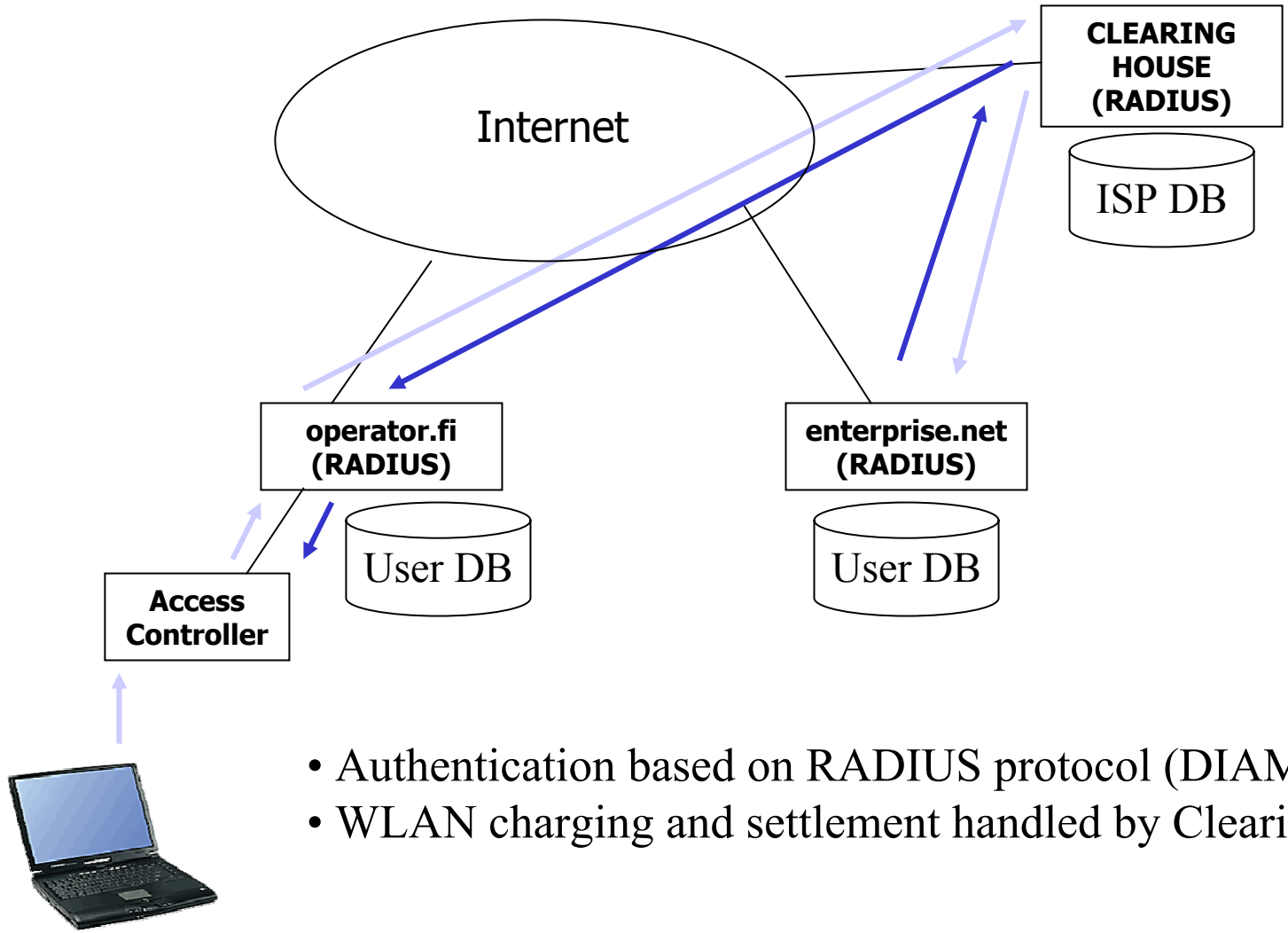
Business model scenarios – Bilateral, Clustered, Centralized

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

- 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

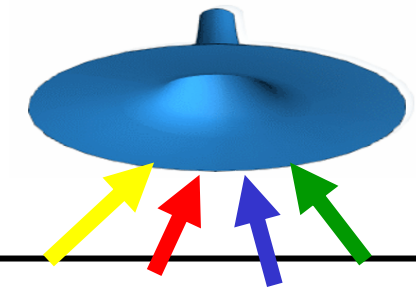
WLAN roaming

Roaming aggregators: case U.S.

Brands/ Service Providers
- End users

Sprint, T-Mobile, EarthLink, FIBERLINK, cingular WIRELESS, AT&T Wireless

Aggregators
- Roaming



BOINGO WIRELESS, iPass, THE CLOUD, cometa NETWORKS

Hotspot Operators
- Networks

net near u, T-Mobile, AT&T Wireless, WAYPORT, Sprint, verizon, Airpath wireless, cometa NETWORKS

Venues
- Locations

STARBUCKS COFFEE, McDonald's, DFW, Hilton, Marriott, BORDERS

Source: Boingo Wireless, 2003

WLAN roaming

Public hotspots per location

	2001	2002	2003	2004	2005	2006	2007
Airports	75	200	400	500	600	650	700
Hotels	520	2,500	9,000	20,000	30,000	40,000	45,000
Retail outlets	320	12,000	44,000	60,000	75,000	85,000	90,000
Enterprise Guesting Areas	84	600	1,000	4,000	5,000	6,000	8,000
Transportation (trains, planes)		100	600	2,000	14,000	23,000	30,000
Community Hotspots	1	300	3,000	5,000	8,000	9,000	12,000
Others		300	1,000	1,500	2,400	3,350	4,300
Total number of hotspots	**1,000**	**16,000**	**59,000**	**93,000**	**135,000**	**167,000**	**190,000**

Source: Gartner

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

WLAN roaming

of public hotspots per region

# of Hot Spots	2001	2002	2003	2004	2005	2006	2007
Europe	50	1,000	5,000	9,400	17,700	24,000	28,200
Americas	750	4,000	18,000	30,000	45,000	55,000	62,000
Far-East	100	10,500	25,000	51,500	69,000	83,000	93,000
ROW		500	1,000	2,100	3,300	5,000	6,800
Total	**900**	**16,000**	**49,000**	**93,000**	**135,000**	**167,000**	**190,000**
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 acces to Internet) $\Rightarrow$ strong trust required between operators
- Roll-out of WLAN in handsets is likely to increase the use of SIM card and HLR 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

  $\Rightarrow$ no national WLAN roaming agreements so far
- Unified roaming tariffs announced within Europe (11 countries, GSM voice call 0.95e/min)