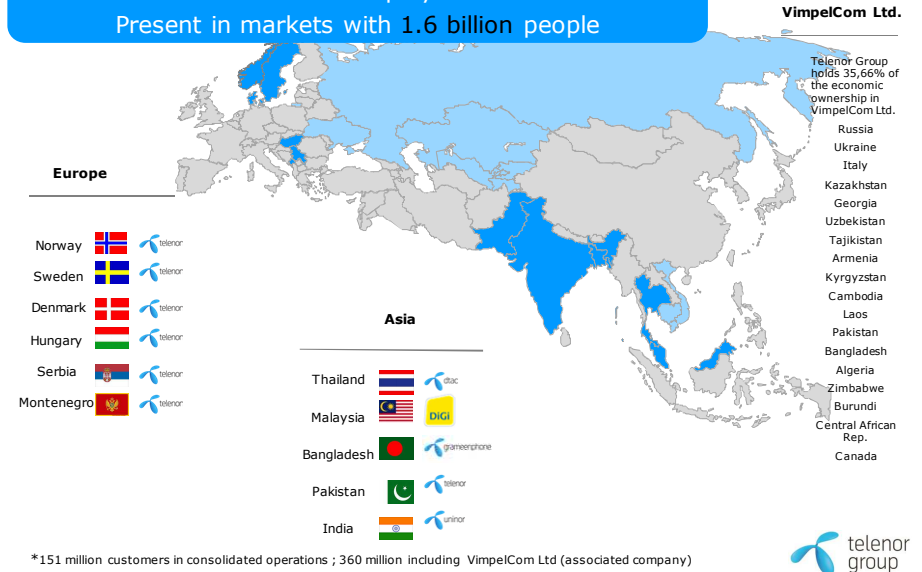


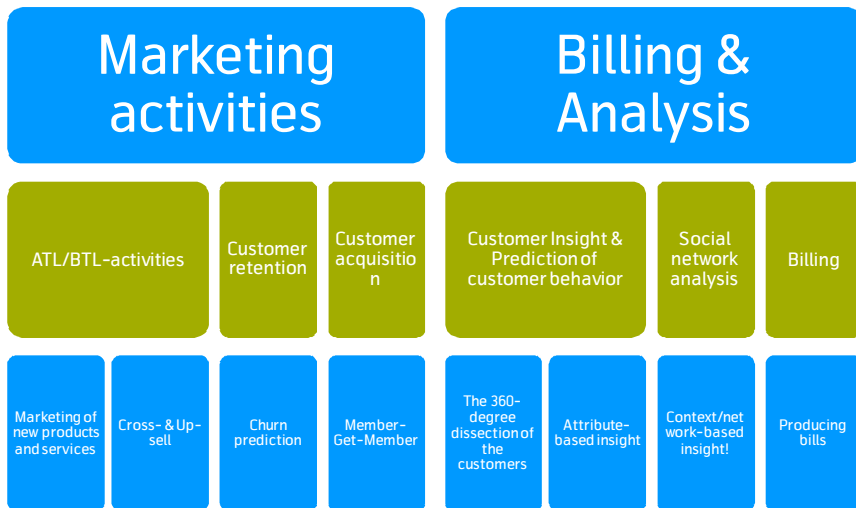
## A telecom perspective

Kent Engø-Monsen @ Telenor Group, Research and Future Studies  
Workshop on time-varying network analysis, Sept. 19, 2012

Among the major mobile operators in the world  
more than 150 million mobile subscribers \*  
31 000 employees  
Present in markets with 1.6 billion people



## What does Telenor need to do with Customer Data?



## HANDSET DIFFUSION

Collaboration with:  
Johannes Bjelland, Geoffrey S. Canright,  
Rich S. Ling and Pål Roe Sundsøy

A_NU...	B_NU...	CELL_ID	LOCATION	TIER3_NAME	MAIN_GROUP	CALLI...	CALLI...	EVENT...	EVENT...	TWIN	DESTINATI...	COST...	PRODUCT
423	20923...	23214...	(null) Norge	SMS i Norge	SMS	(null)	(null)	(null)	(null)	(null)	(null)	(null)	04720
426	46240...	24002...	242012070143948 Norge	Til operatør hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	X-NETV...	04720
429	46240...	30590...	242012070143948 Norge	Til fastnett	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	F-FAST...	04720
430	46240...	23630...	242012070143948 Norge	Til operatør hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	X-NETV...	04720
431	46240...	24002...	242012070143948 Norge	Til operatør hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	X-NETV...	04720
432	46240...	11168...	242012070143948 Norge	Til operatør hos Netcom	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)	F-FAST...	04720
433	48311...	45754...	0 Norge	Viderekobling i Telenors Nett Tale	Tale	(null)	242010...	15.02.2011	(null)	(null)	(null)	M-MOB1...	04577
434	48311...	(null)	(null) Norge	Internet	Internet	(null)	242010...	14.02.2011	45259	(null)	(null)	T3-VOT	04577
435	48311...	(null)	(null) Norge	Internet	Internet	(null)	242010...	14.02.2011	297421	(null)	(null)	T3-VOT	04577
436	48311...	(null)	(null) Norge	Internet	Internet	(null)	242010...	14.02.2011	(null)	(null)	(null)	(null)	(null)
437	48311...	(null)	(null) Norge	Internet	Internet	(null)	242010...	15.02.2011	(null)	(null)	(null)	(null)	(null)
438	48311...	(null)	(null) Norge	Internet	Internet	(null)	242010...	15.02.2011	(null)	(null)	(null)	(null)	(null)
439	48311...	(null)	(null)	(null)	Internet	(null)	242010...	14.02.2011	152	(null)	(null)	T3-VOT	04577
440	48311...	(null)	(null)	(null)	Internet	(null)	242010...	15.02.2011	70509	(null)	(null)	T3-VOT	04577
441	48311...	(null)	(null)	(null)	Internet	(null)	242010...	15.02.2011	144	(null)	(null)	T3-VOT	04577
442	48311...	(null)	(null)	(null)	Internet	(null)	242010...	14.02.2011	3711	(null)	(null)	T3-VOT	04577
443	48311...	(null)	(null)	(null)	Internet	(null)	242010...	15.02.2011	3202	(null)	(null)	T3-VOT	04577
444	48311...	(null)	(null) Norge	Internet	Internet	(null)	242010...	15.02.2011	152	(null)	(null)	T3-VOT	04577
445	45047...	49639...	(null) Norge	SMS i Norge	SMS	(null)	242010...	15.02.2011	(null)	(null)	(null)	(null)	04747
446	22637...	(null)	(null) Utdand	GPFS i utland	SMS	(null)	242010...	15.02.2011	341	(null)	(null)	T3-VOT	(null)
447	46935...	23959...	242012090150195 Norge	NR - Utgående SMS	SMS	(null)	242010...	15.02.2011	(null)	(null)	(null)	(null)	(null)
448	23170...	(null)	242011450118026 Utdand	NR - Inngående tale/data/Ex	SMS	(null)	(null)	(null)	(null)	(null)	(null)	(null)	(null)
449	23698...	(null)	242011560112573 Utdand	NR - Inngående tale/data/Ex	SMS	(null)	(null)	(null)	(null)	(null)	(null)	(null)	(null)
450	29651...	(null)	(null) Norge	NR Pakkeside	SMS	(null)	242010...	15.02.2011	28754	(null)	(null)	T3-VOT	(null)
451	48376...	23959...	(null) Norge	NR - Inngående SMS	SMS	35536...	242059...	15.02.2011	(null)	(null)	(null)	T3-TAZ...	(null)
1792	23825...	36243...	0 Norge	Til fastnett	Tale	(null)	(null)	15.02.2011	(null)	(null)	(null)	F-FAST...	04008
1793	23825...	45754...	0 Norge	Viderekobling i Telenors Nett Tale	Tale	(null)	(null)	15.02.2011	(null)	(null)	(null)	M-MOB1...	04008
1794	130055	45558...	(null) Norge	(null)	(null)	(null)	(null)	15.02.2011	(null)	(null)	(null)	(null)	02092
1795	47589...	45550...	(null) Norge	(null)	(null)	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04140
1796	47589...	24063...	(null) Norge	(null)	(null)	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04140
1797	47589...	24063...	(null) Norge	SMS i Norge	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04140
1798	47589...	49864...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1799	47589...	45797...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1800	47589...	45006...	(null) Norge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1801	47589...	45972...	(null) Norge	Intert til kollega - SMS	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)	(null)	04140
1802	46633...	47516...	242015040147145 Utdand	NR - Utgående tale	Tale	35628...	242050...	14.02.2011	(null)	(null)	(null)	2-TR-MOC	(null)
1803	22600...	45001...	(null) Norge	NR - Inngående SMS	SMS	35486...	242050...	14.02.2011	(null)	(null)	(null)	(null)	(null)
1804	46642...	45001...	(null) Norge	NR - Inngående SMS	SMS	11808...	242050...	15.02.2011	(null)	(null)	(null)	(null)	(null)
1805	46009...	49792...	(null) Utdand	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04712
1806	46009...	20022...	(null) Utdand	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04712
1807	46009...	20022...	(null) Utdand	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)	(null)	04712

# Anonymized CDR data—our starting point

A number - Caller

B number - Receiving party

Date & time

Type: Call, SMS, Data, etc

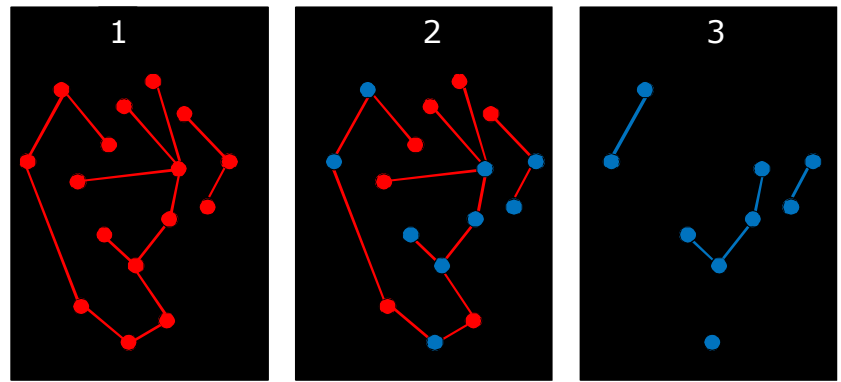
Data volume

Cell ID: Location

IMSI: SIM card

TAC: Handset

It is practical to define the adoption network

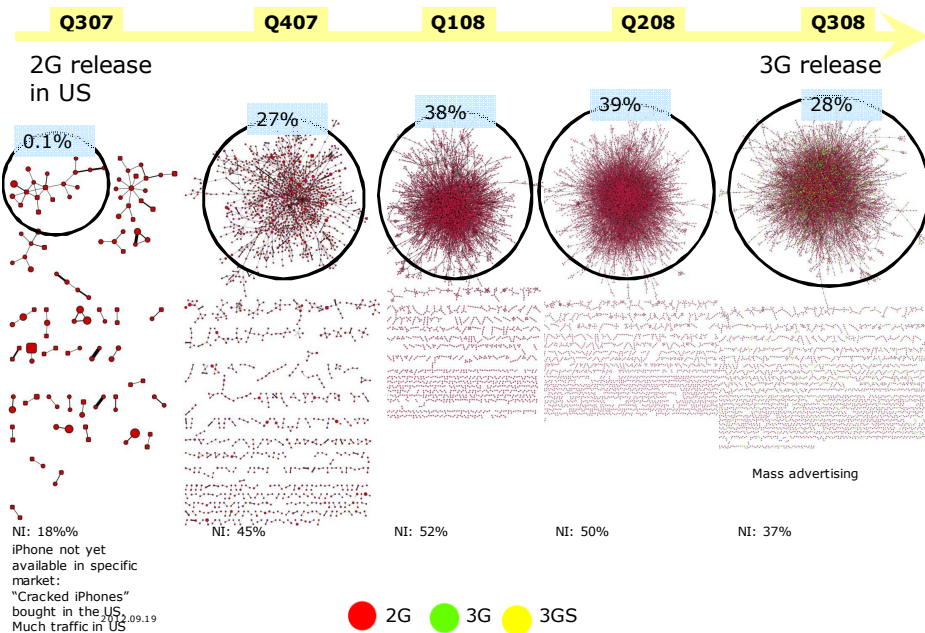


Social network → Social network + adoption history → Adoption network

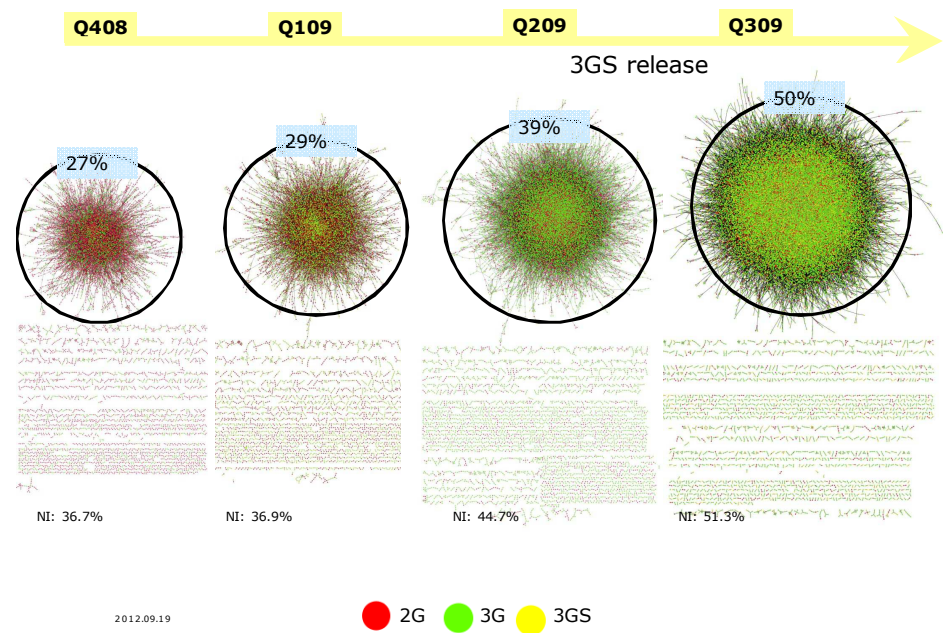
2012.09.19



## The iPhone adoption network evolution

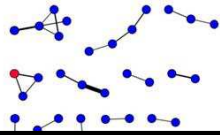


## The iPhone adoption network evolution



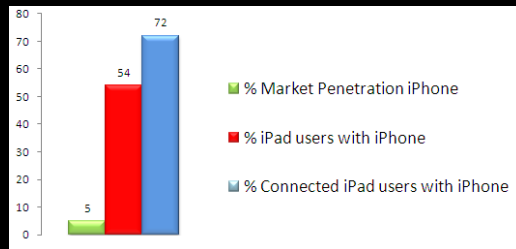
2012.09.19

# iPad 3G



● = iPad user with iPhone  
 ● = iPad user with other handset  
 Links are social relations based on SMS+Voice

## "The Apple Tribe"



- 54% of the iPad users also uses iPhone (5% market penetration of iPhone)
- If the iPad user is connected to another iPad user the chance of having an iPhone is 72%

July'10    Aug'10    Sept'10    Oct'10    Nov'10

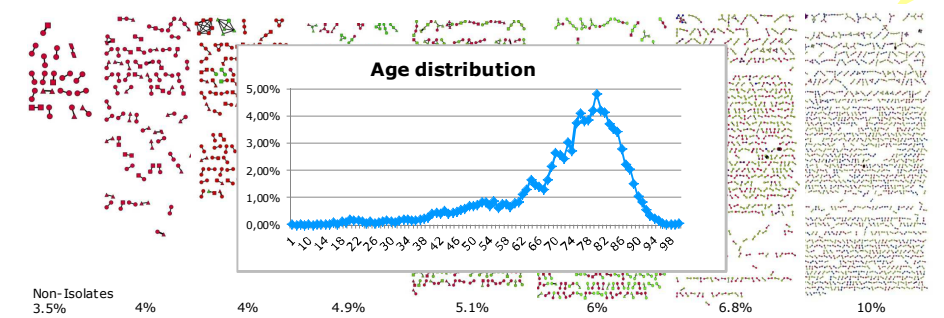
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# The DORO adoption network evolution

Q407    Q108    Q208    Q308    Q408    Q109    Q209    Q309



Adoption of the Doro handset; an individual choice?  
 Or the choice of the user's children who wish to be in contact with their elderly parents?

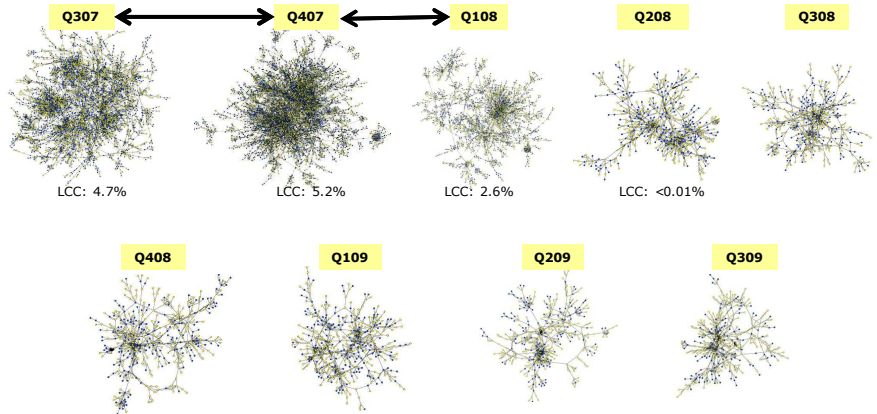
2012.09.19

● Doro HandleEasy 326,328    ● Doro PhoneEasy 410  
 ● Doro HandleEasy 330    ● Other Doro (338,345,409)  
 Age: □ <25    △ 25-55  
 ▽ 55-70    ○ >70



# The Mobile Video Telephony network evolution

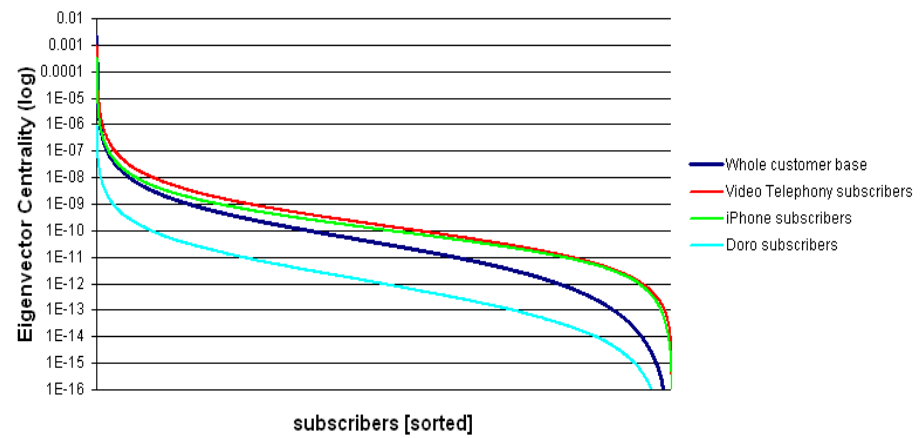
Increased # of adopters in LCC    Collapse of LCC



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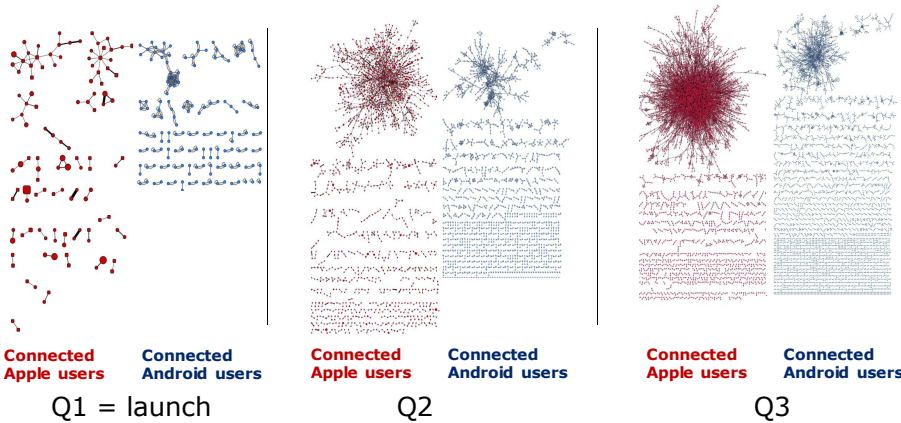
# iPhone users have high EVC



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## Apple vs. Android



Apple users form a 'dense core' of highly social users

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## You do what your **friends** do

If you have one friend with iPad, your propensity to also buy iPad will be **14** times higher.

Exploit the social circle to target customers with high social product pressure



2012.09.19



## CLUSTERING

Collaboration with:  
T. Binh Phan and Øystein D. Fjeldstad

2012.09.19



## Building new weighted clustering measures

### Three factors:

- Connectedness
- Strength of T1/2
- Relative strength of T3 to T1/2

### Property:

- Reduce to the classical unweighted version for identical weights

$$C = \frac{\sum_i \sqrt{\sqrt{w_{i,1} w_{i,2}} \sqrt[3]{w_{i,1} w_{i,2} w_{i,3}}}}{\sum_i \sqrt{w_{i,1} w_{i,2}}} \quad \text{Geometric mean}$$

$$C = \frac{\sum_i \frac{1}{2} \left( \frac{w_{i,1} + w_{i,2}}{2} + \frac{w_{i,1} + w_{i,2} + w_{i,3}}{3} \right) a_{i,1} a_{i,2} a_{i,3}}{\sum_i \frac{w_{i,1} + w_{i,2}}{2}} \quad \text{Arithmetic Mean}$$

$$C = \frac{\sum_i \left( \frac{1}{2} \left( \left( \frac{w_{i,1}^2 + w_{i,2}^2}{2} \right)^2 + \left( \frac{w_{i,1}^2 + w_{i,2}^2 + w_{i,3}^2}{3} \right)^2 \right) \right) a_{i,1} a_{i,2} a_{i,3}}{\sum_i \sqrt{\frac{w_{i,1}^2 + w_{i,2}^2}{2}}} \quad \text{Quadratic Mean}$$

### 'Problem':

- Do we need more weighted clustering measures?
- We need to figure out their properties!

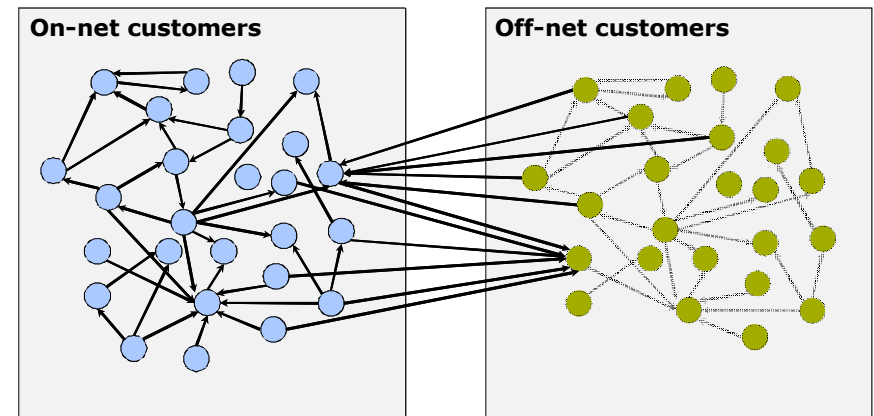


# ON-NET AND OFF-NET .... MISSING DATA

2012.09.19



## The social network among customers - On-net & Off-net



Who is an attractive customer?

2012.09.19



# CHALLENGES

2012.09.19



## Challenges / questions

- Diffusion {
  - The 'BIG' question: When does a service take off?
  - Who will adopt?
  
- Time-evolving networks {
  - Time-averaging over dynamic network data (current approach) vs. true dynamic measures – Benefits / value?
  - The problem of missing data (on-net vs. off-net)
  - Multi-SIM behavior: 'Identifying' the same customer
  
- Structure of social network: {
  - What are valuable structural properties of the network (customer base)?:
  - Centrality of customer set
  - Different roles: Originating and terminating
  - Which clustering measures are important?
  - Competition with other network providers

2012.09.19

