

Telenor Research

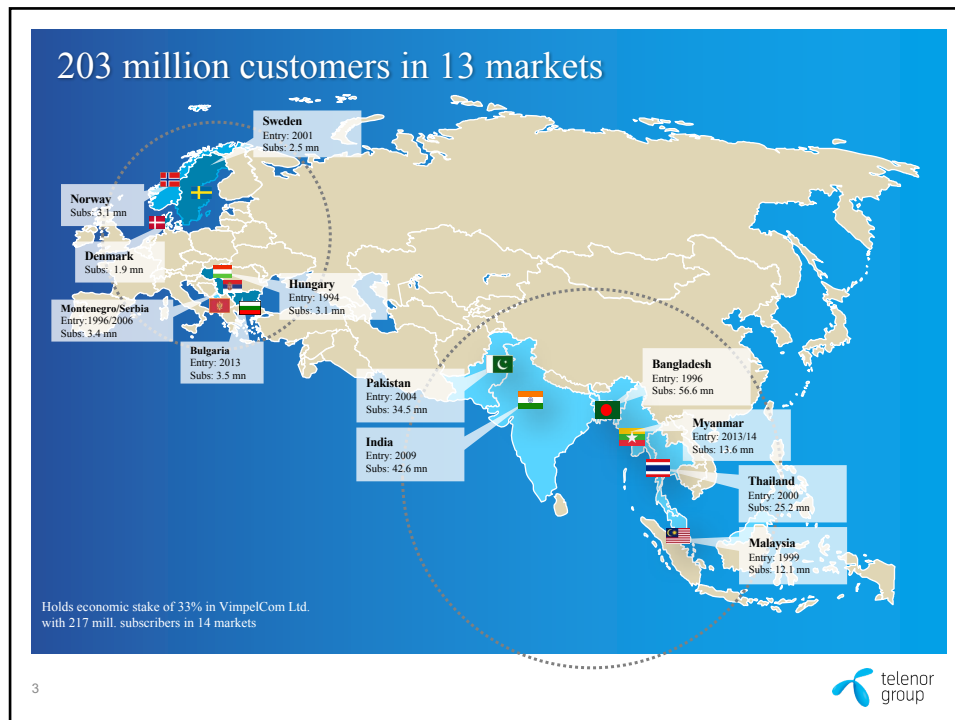
- Building knowledge to define the future

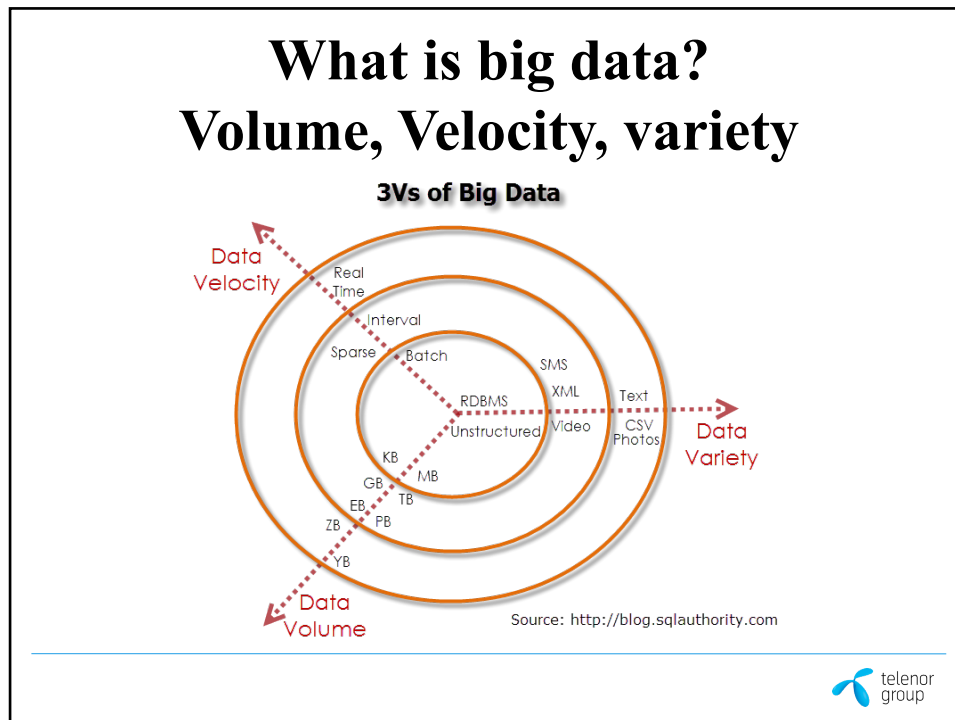
Big Data for Social Good

2017.09.20 Novi Sad, Serbia

Kenth Engø-Monsen, PhD
Senior Data Scientist
Analytics and AI
Telenor Research







What is big data?

Different corporate culture

THE MAGAZINE
October 2012

Big Data: The Management Revolution
by Andrew McAfee and Erik Brynjolfsson

Comments (29)



Artwork: Tamar Cohen, *Happy Motoring*, 2010, silk screen on vintage road map, 26" x 18"
"You can't manage what you don't measure."

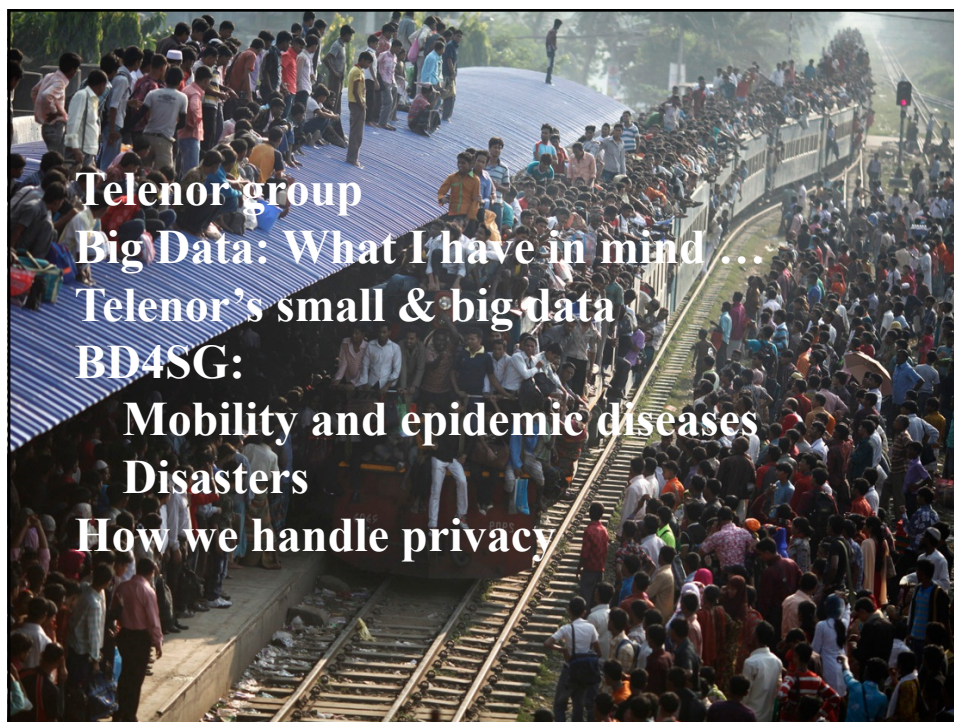
SUBSCRIBE TO ALL-ACCESS
SAVE 79% PLUS RECEIVE THE FREE GUIDE LEADERSHIP INSIGHTS UPON PAYMENT

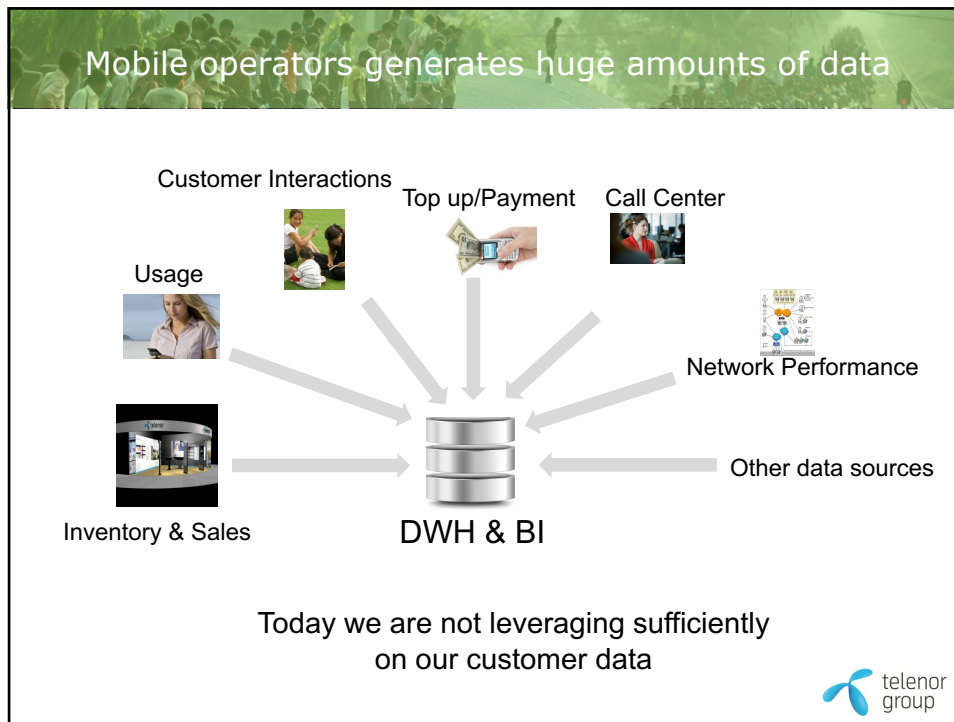
What's It Take to Get a Top Job?
HARVARD BUSINESS REVIEW FREE WEBINAR
MAR 14 @ NOON EST
REGISTER NOW

Sponsored by **accenture**

TOP MAGAZINE ARTICLES
24 HOURS 7 DAYS 30 DAYS

1. How to Give a Killer Presentation
2. Overloaded Circuits: Why Smart People Underperform
3. Manage Your Work, Manage Your Life





Billing data →
Stored for each call, sms and data session

LINE	NUM	CHL ID	LOC	TYPE	NAME	MAIN GROUP	CALL	CALL	PORT	EXT	TWIN	ESTIMAT	COST	PRODUC
423	20923...													04720
424	20923...													04720
425	20923...													04720
426	24115...													04720
427	46240...													04720
428	46240...	24002...	242012070143948	Morge	Til operatør hos Netcoa	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)		X-NETV... 04720
429	46240...	30598...	242012070143948	Morge	Til fastnett	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)		F-FAST... 04720
430	46240...	24002...	242012070143948	Morge	Til operatør hos Netcoa	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)		X-NETV... 04720
431	46240...	24002...	242012070143948	Morge	Til operatør hos Netcoa	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)		X-NETV... 04720
432	46240...	11168...	242012070143948	Morge	Til operatør hos Netcoa	Tale	12164...	242010...	15.02.2011	(null)	(null)	(null)		F-FAST... 04720
433	48311...	45754...	0	Morge	Viderekobling i Telenors Nett	Tale	(null)	242010...	15.02.2011	(null)	(null)	(null)		M-MOBI... 04577
434	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	14.02.2011	45259	(null)	(null)		T3-VOT 04577
435	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	14.02.2011	297421	(null)	(null)		T3-VOT 04577
436	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	14.02.2011		(null)	(null)		T3-VOT 04577
437	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	14.02.2011		(null)	(null)		T3-VOT 04577
438	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	15.02.2011		(null)	(null)		T3-VOT 04577
439	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	14.02.2011	152	(null)	(null)		T3-VOT 04577
440	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	15.02.2011	70509	(null)	(null)		T3-VOT 04577
441	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	15.02.2011	144	(null)	(null)		T3-VOT 04577
442	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	14.02.2011	3711	(null)	(null)		T3-VOT 04577
443	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	15.02.2011	3202	(null)	(null)		T3-VOT 04577
444	48311...	(null)	(null)	Morge	Internett	Internett	(null)	242010...	15.02.2011	152	(null)	(null)		T3-VOT 04577
445	45047...	49639...	(null)	Morge	SMS i Norge	SMS	(null)	242010...	15.02.2011	(null)	(null)	(null)		04747
446	22637...	(null)	(null)	Utlend	GPRS i utland		(null)	242010...	15.02.2011	341	(null)	(null)		T3-VOT (null)
447	46935...	23959...	242012060150195	Morge	NR - Utgående SMS	SMS	(null)	242010...	15.02.2011	(null)	(null)	(null)		(null)
448	23170...	(null)	242011450118026	Utlend	NR - Inngående tale/data/fax	Tale	(null)	242010...	15.02.2011	(null)	(null)	(null)		(null)
449	23698...	(null)	242011560112773	Utlend	NR - Inngående tale/data/fax	Tale	(null)	242010...	15.02.2011	(null)	(null)	(null)		(null)
450	29651...	(null)	(null)	Morge	NR Pakkedata		(null)	242010...	15.02.2011	28754	(null)	(null)		T3-VOT (null)
451	48376...	23959...	(null)	Morge	NR - Inngående SMS	SMS	35536...	242059...	15.02.2011	(null)	(null)	(null)		T3-TA2... (null)
1792	23825...	36243...	0	Morge	Til fastnett	Tale	(null)	(null)	15.02.2011	(null)	(null)	(null)		F-FAST... 04008
1793	23825...	45754...	0	Morge	Viderekobling i Telenors Nett	Tale	(null)	(null)	15.02.2011	(null)	(null)	(null)		M-MOBI... 04008
1794	130055	45558...	(null)	Morge			(null)	(null)	15.02.2011	(null)	(null)	(null)		02092
1795	47589...	24063...	(null)	Morge			(null)	242013...	14.02.2011	(null)	(null)	(null)		04140
1796	47589...	24063...	(null)	Morge			(null)	242013...	14.02.2011	(null)	(null)	(null)		04140
1797	47589...	24063...	(null)	Morge	SMS i Norge	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)		04140
1798	47589...	49864...	(null)	Morge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)		04140
1799	47589...	45797...	(null)	Morge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)		04140
1800	47589...	45006...	(null)	Morge	SMS i Norge	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)		04140
1801	47589...	45872...	(null)	Morge	Internett til kollega - SMS	SMS	(null)	242013...	15.02.2011	(null)	(null)	(null)		04140
1802	46633...	47516...	242015040147145	Utlend	NR - Utgående tale	Tale	35623...	242050...	14.02.2011	(null)	(null)	(null)		2-NR-MOC (null)
1803	22600...	45001...	(null)	Morge	NR - Inngående SMS	SMS	35486...	242050...	14.02.2011	(null)	(null)	(null)		04140
1804	46642...	45001...	(null)	Morge	NR - Inngående SMS	SMS	11808...	242050...	15.02.2011	(null)	(null)	(null)		04140
1805	46809...	49792...	(null)	Morge	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)		04712
1806	46809...	20994...	03.07	Utlend	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)		04712
1807	46809...	20922...	(null)	Utlend	Fri bruk SMS i	SMS	(null)	242013...	14.02.2011	(null)	(null)	(null)		04712

A number - Caller

B number - Receiving party

Type: Call, SMS, Data, etc

Date & time

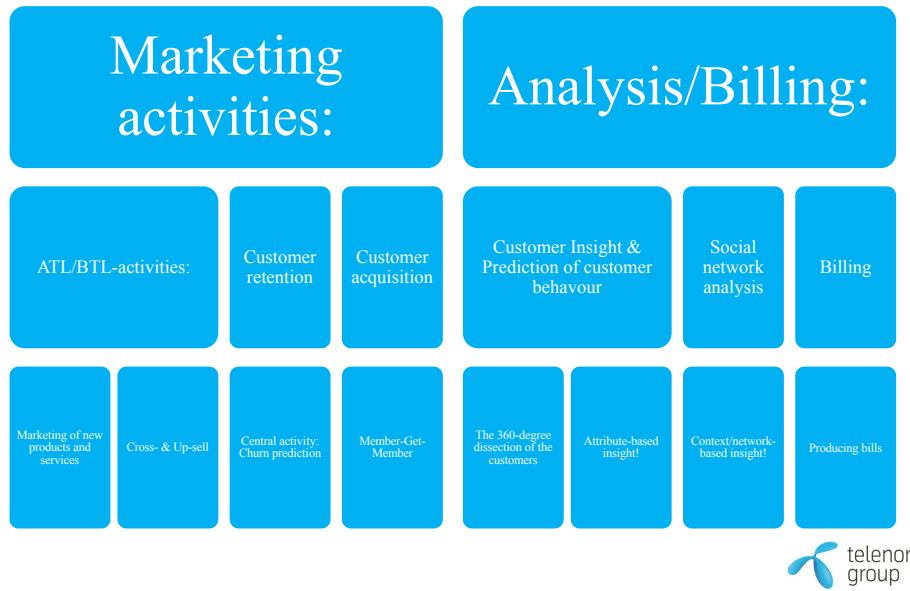
Data volume

Cell_ID: Location

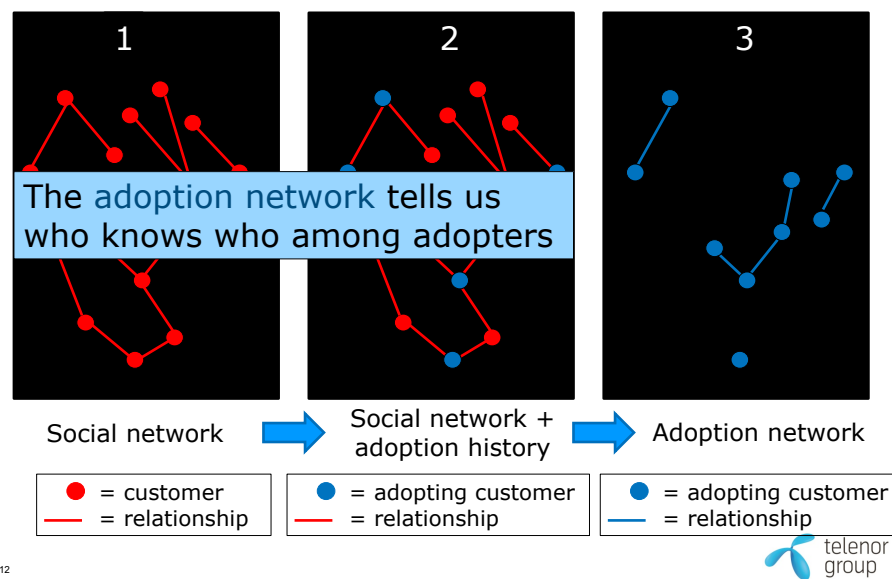
IMSI: SIM card

TAC: Handset

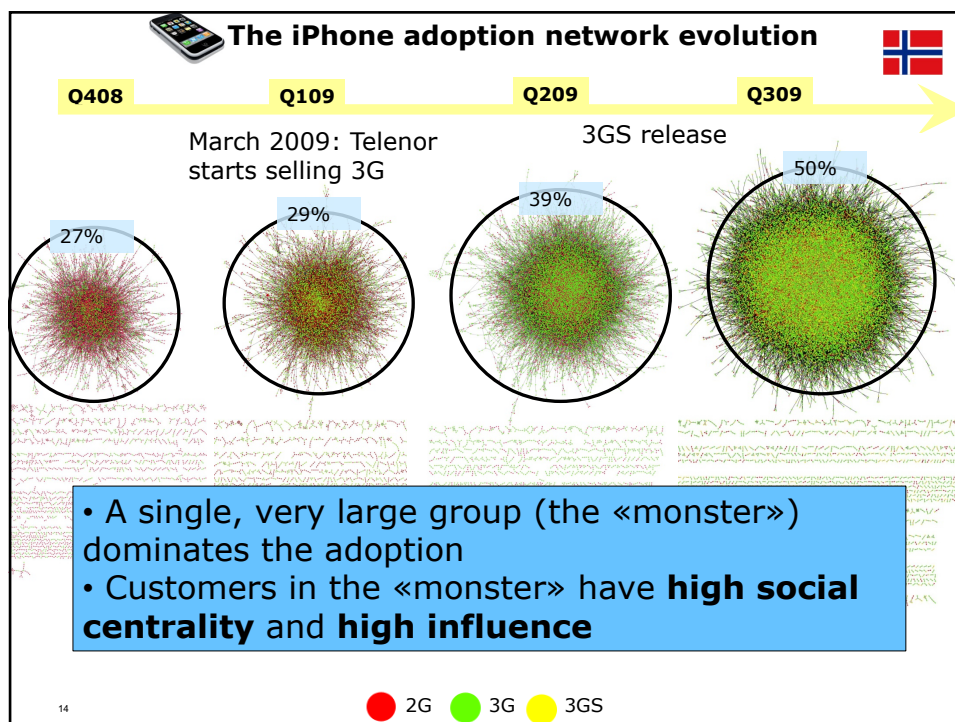
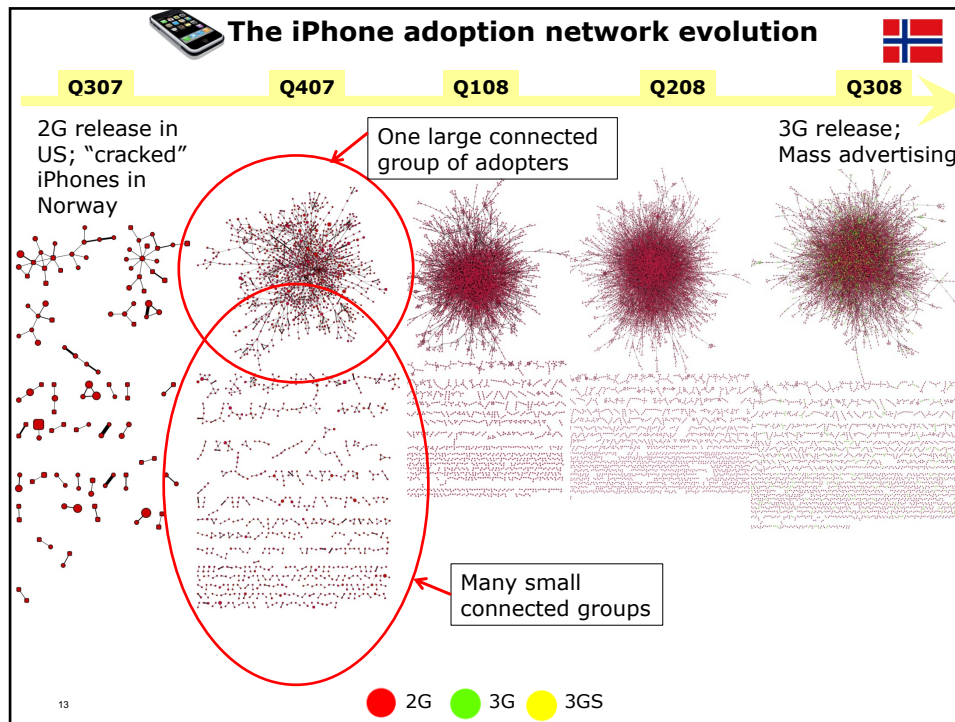
What does Telenor need to do with Customer Data?

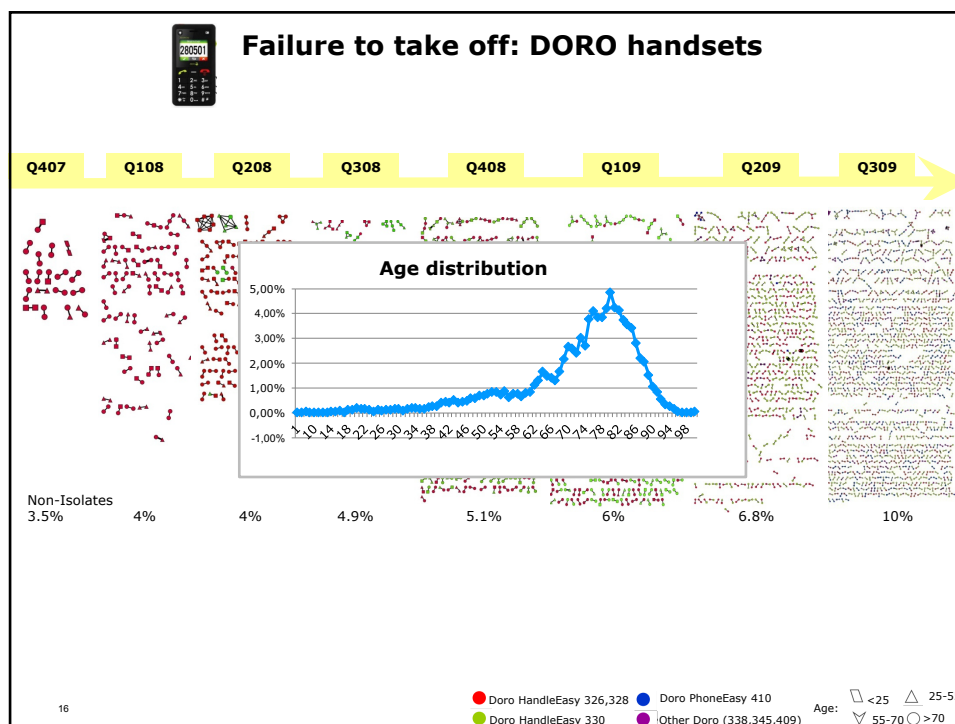
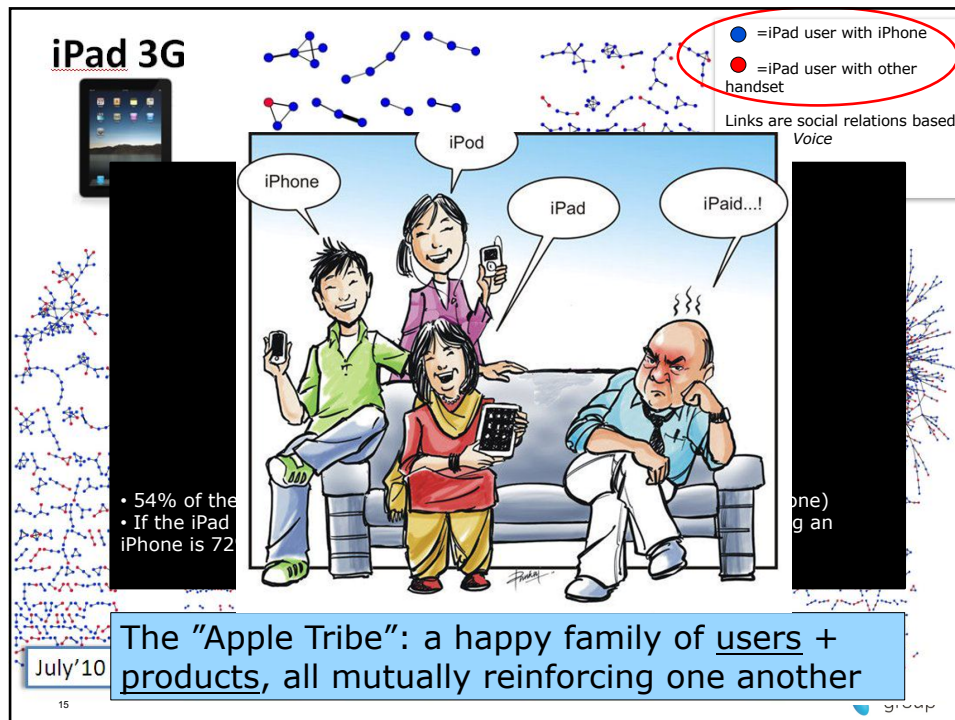


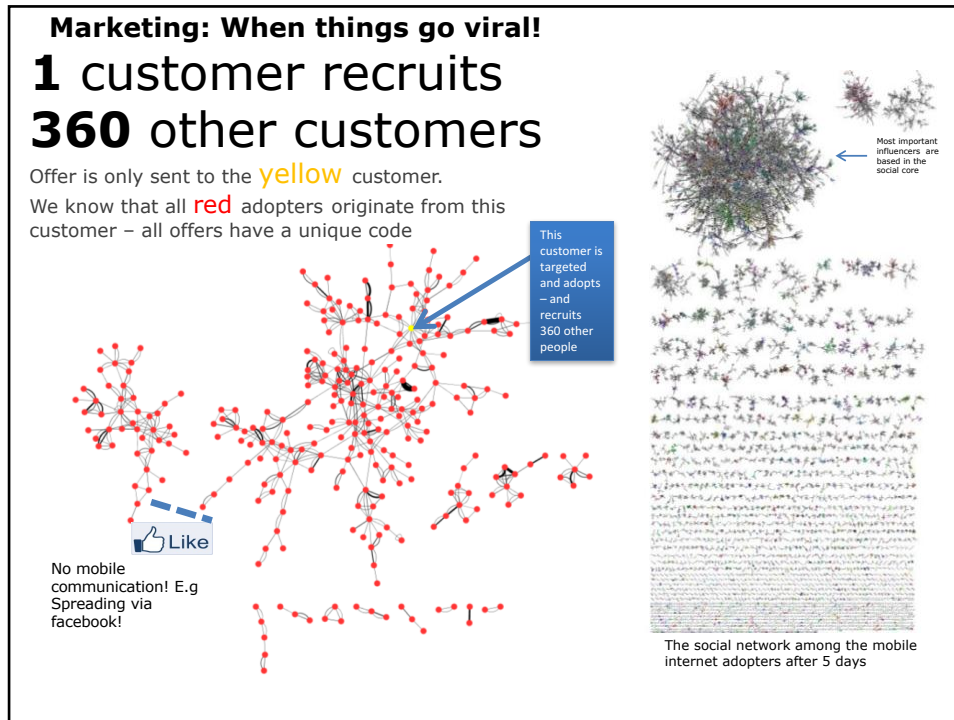
Let us get familiar with something called the "adoption network"



12









Principles of BD4SG

BIG impact & shared value
is our goal

Our **DATA & EXPERTISE** is
our contribution

Handling data
RESPONSIBLY is key

COLLABORATION is the
name of the game

Billing data →

Stored for each call, sms and data session

	A number - Caller	B number - Receiving party	Type: Call, SMS, Data, etc	Cell_ID: Location	Date & time	IMSI: SIM card	TAC: Handset	Data volume
423	20923...							04720
424	20923...							04720
425	20923...							04720
426	24115...							(null)
427	46240...							04720
428	46240... 24002...	242012070143940 Morge	Til operatorer hos Netcom	Tale	12164... 242010... 15.02.2011	(null) (null)	X-METW...	04720
429	438... 30598...	242012070143940 Morge	Til fastnett	Tale	12164... 242010... 15.02.2011	(null) (null)	F-FAST...	04720
430	46240... 24002...	242012070143940 Morge		Tale	12164... 242010... 15.02.2011	(null) (null)	X-METW...	04720
431	46240... 24002...	242012070143940 Morge		Tale	12164... 242010... 15.02.2011	(null) (null)	X-METW...	04720
432	46240... 11168...	242012070143940 Morge		Tale	12164... 242010... 15.02.2011	(null) (null)	F-FAST...	04720
433	48311... 45754...	0 Morge	Viderkobling i Telenors Nett	Tale	12164... 242010... 15.02.2011	(null) NOR	M-HOBI...	04577
434	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 14.02.2011	45259 (null)	T3-VOT	04577
435	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 14.02.2011	29742 (null)	T3-VOT	04577
436	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 14.02.2011			
437	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011			
438	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011			
439	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011			
440	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011	70509 (null)	T3-VOT	04577
441	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011	144 (null)	T3-VOT	04577
442	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 14.02.2011	3711 (null)	T3-VOT	04577
443	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011	3202 (null)	T3-VOT	04577
444	48311... (null)	(null) Morge	Internet	Internet	(null) 242010... 15.02.2011	152 (null)	T3-VOT	04577
445	45047... 49639...	(null) Morge	SMS i Norge	SMS	(null) 242010... 15.02.2011	(null) (null)	(null)	04747
446	26377... (null)	(null) Umland	GPRS i utlandet	SMS	(null) 242010... 15.02.2011	34 (null)	T3-VOT	(null)
447	46935... 23959...	242012080150195 Morge	NR - Uglyende SMS	SMS	(null) 24201... 15.02.2011			
448	23170... (null)	242014450118026 Umland	NR - Inngående tale/data/etc	Tale	(null) (null) 15.02.2011	(null) (null)	S-HRC	(null)
449	46936... (null)	242011560123753 Umland	NR - Inngående tale/data/etc	Tale	(null) (null) 15.02.2011	28754 (null)	T3-VOT	(null)
450	29651... (null)	(null) Morge	NR Pakketele	SMS	(null) 24201... 15.02.2011	(null) (null)	T3-TA2...	(null)
451	48376... 23959...	(null) Morge	NR - Inngående SMS	SMS	35536... 242059... 15.02.2011	(null) (null)		
452	1792 23825... 36243...	0 Morge	Til fastnett	Tale	(null) (null) 15.02.2011	(null) (null)	F-FAST...	04008
453	1792 23825... 45754...	0 Morge	Viderkobling i Telenors Nett	Tale	(null) (null) 15.02.2011	(null) (null)	M-HOBI...	04008
454	130055 45558...	(null) Morge			(null) (null) 15.02.2011	(null) (null)		02092
455	47589... 45550...	(null) Morge			(null) 24201... 15.02.2011	(null) (null)		04140
456	47589... 24063...	(null) Morge			(null) 242013... 15.02.2011	(null) (null)		04140
457	47589... 24063...	(null) Morge	SMS i Norge	SMS	(null) 242013... 14.02.2011	(null) (null)		04140
458	47589... 49864...	(null) Morge	SMS i Norge	SMS	(null) 242013... 15.02.2011	(null) (null)		04140
459	47589... 45797...	(null) Morge	SMS i Norge	SMS	(null) 242013... 15.02.2011	(null) (null)		04140
460	47589... 45006...	(null) Morge	SMS i Norge	SMS	(null) 242013... 15.02.2011	(null) (null)		04140
461	47589... 45072...	(null) Morge	Internat til kollegaer - SMS	SMS	(null) 242013... 15.02.2011	(null) (null)		04140
462	46633... 47516...	242015040174145 Umland	NR - Uglyende tale	Tale	35629... 242050... 14.02.2011	(null) (null)	Z-NR-NOC	(null)
463	22600... 45001...	(null) Morge	NR - Uglyende SMS	SMS	35486... 242050... 14.02.2011	(null) (null)		(null)
464	46642... 45001...	(null) Morge	NR - Inngående SMS	SMS	11608... 242050... 15.02.2011	(null) (null)		(null)
465	46909... 49792...	(null) Umland	Fri bruk SMS i	SMS	(null) 242013... 14.02.2011	(null) (null)		04712
466	46909... 206914.03.07	(null) Umland	Fri bruk SMS i	SMS	(null) 242013... 14.02.2011	(null) (null)		04712
467	46909... 70022...	(null) Umland	Fri bruk SMS i	SMS	(null) 242013... 14.02.2011	(null) (null)		04712

Some questions a mobile operator can help investigate



Where are the people?



How do people move around in a country?



What are people's financial activity?



What is the real-time behavior of people?



Impact of human mobility on the emergence of dengue epidemics in Pakistan

Amy Wesolowski^{a,b}, Taimur Qureshi^c, Maciej F. Boni^{d,e}, Pål Roe Sundsøy^c, Michael A. Johansson^{b,f}, Syed Basit Rasheed^g, Kenth Engø-Monsen^c, and Caroline O. Buckee^{a,b,1}

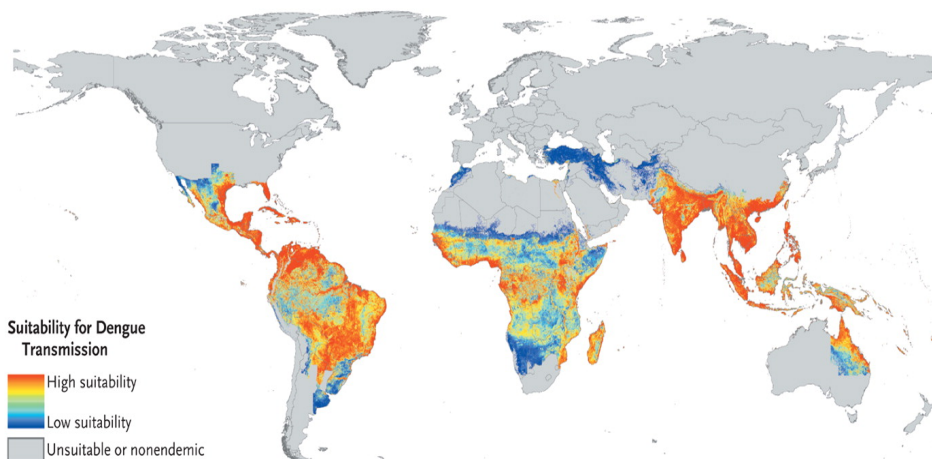
^aDepartment of Epidemiology, Harvard T. H. Chan School of Public Health, Boston, MA 02115; ^bCenter for Communicable Disease Dynamics, Harvard T. H. Chan School of Public Health, Boston, MA 02115; ^cTelenor Research, Telenor Group, N-1360 Fornebu, Norway; ^dOxford University Clinical Research Unit, Wellcome Trust Major Overseas Programme, Ho Chi Minh City, Vietnam; ^eCentre for Tropical Medicine, Nuffield Department of Clinical Medicine, University of Oxford, Oxford OX3 7FZ, United Kingdom; ^fDivision of Vector-Borne Diseases, Centers for Disease Control, San Juan, Puerto Rico 00920; and ^gDepartment of Zoology, University of Peshawar, Peshawar 25120, Pakistan

PNAS | September 22, 2015 | vol. 112 | no. 38 | 11887–11892
URL: www.pnas.org/cgi/doi/10.1073/pnas.1504964112



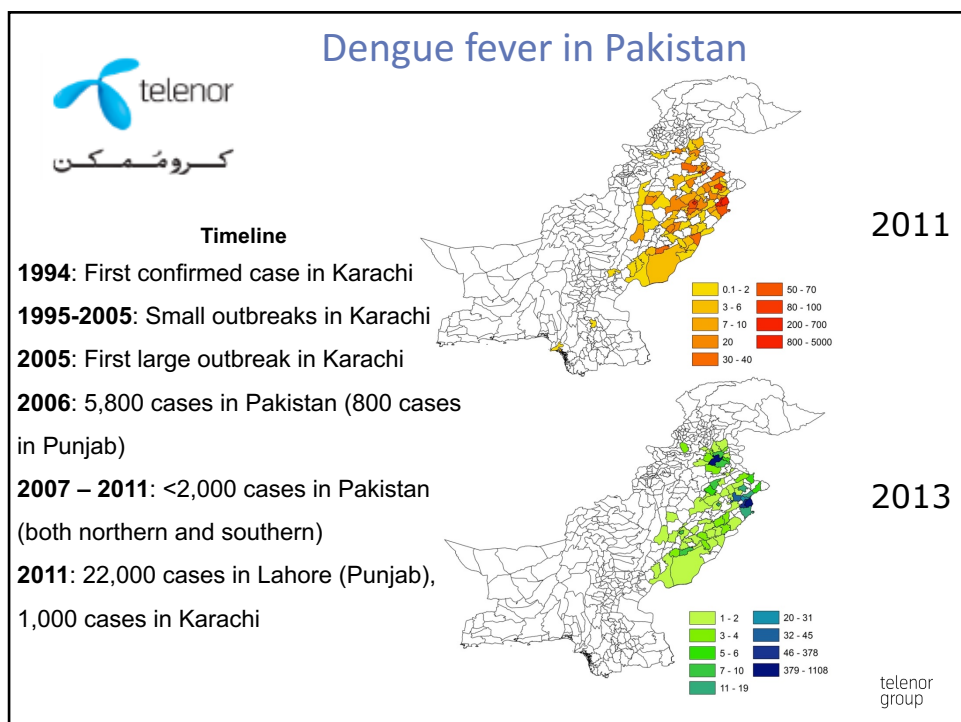
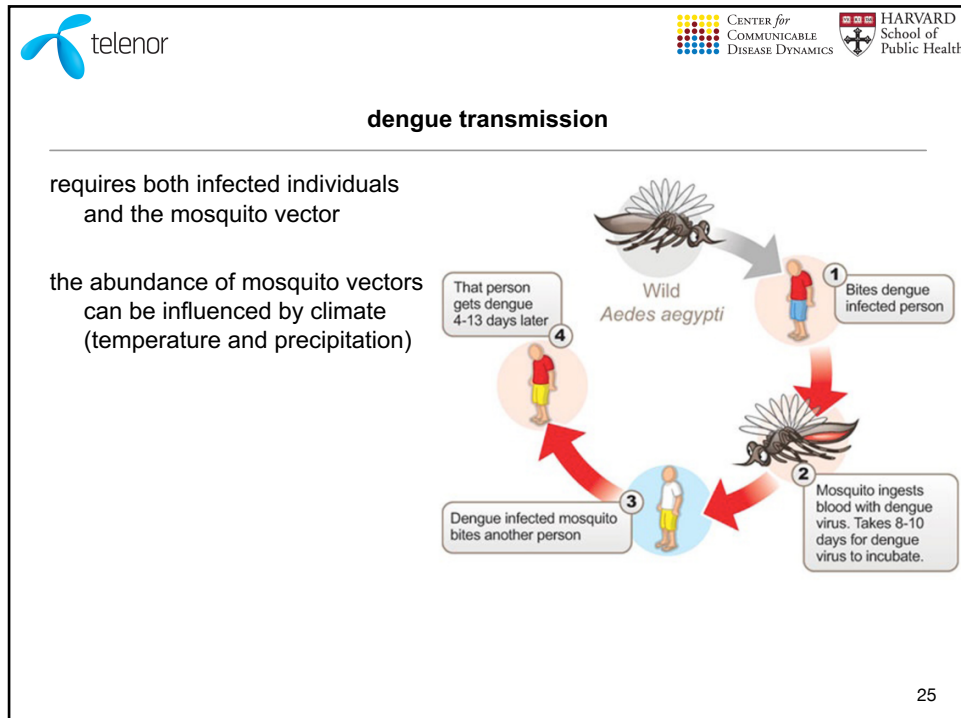
- Unique interdisciplinary collaboration between industry and researchers
- Unprecedented scale in terms of mobile phone data
- Proof of principle and illustration of how to move forward on privacy issues

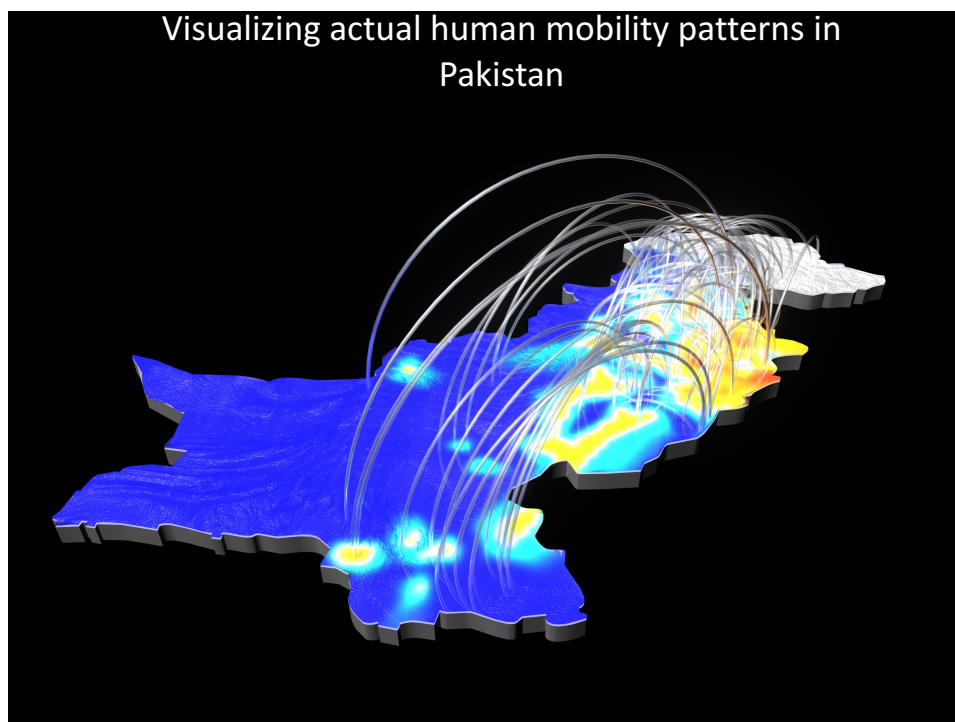
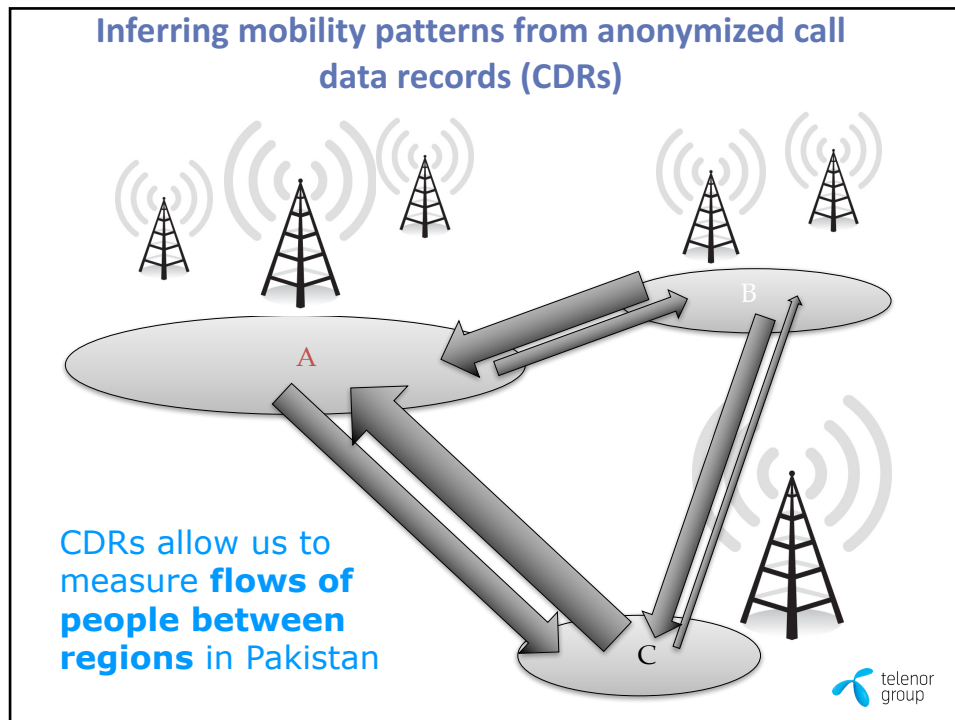
Dengue fever world-wide

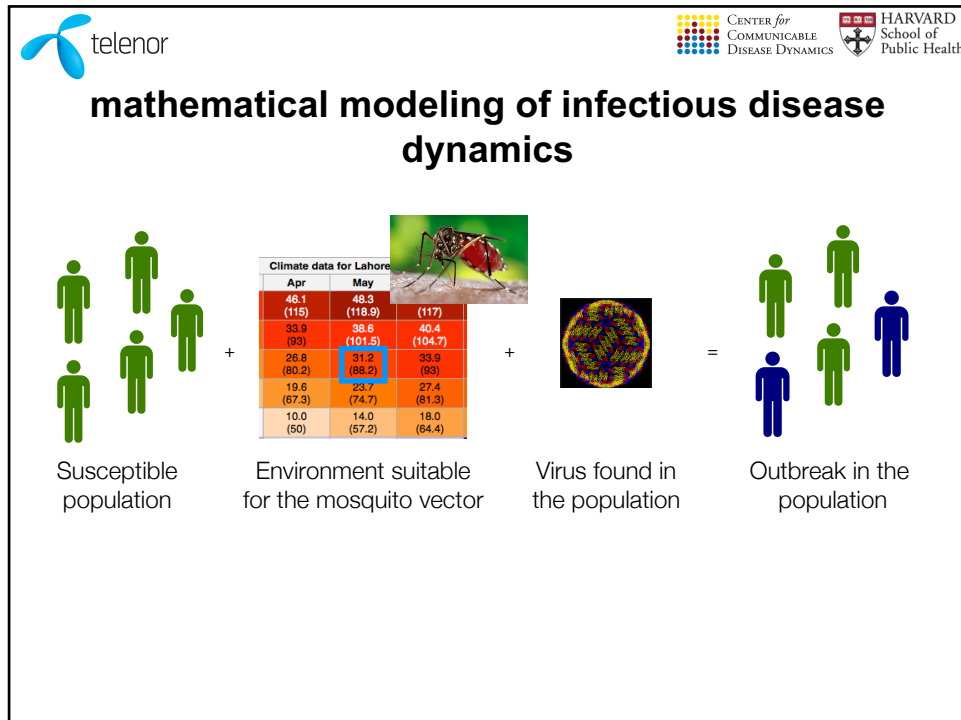


Simmons CP et al. N Engl J Med 2012;366:1423-1432.









Humans

$$\frac{dS_h}{dt} = -\lambda^{v \rightarrow h}$$

$$\frac{dE_h}{dt} = \lambda^{v \rightarrow h} - \gamma^h E_h$$

$$\frac{dI_h}{dt} = \gamma^h E_h - \sigma^h I_h$$

$$\frac{dR_h}{dt} = \sigma^h I_h$$

$$N = S_h + E_h + I_h + R_h.$$

Mosquitos

$$\frac{dA}{dt} = \theta_A \left(1 - \frac{A}{K}\right) V - (\epsilon_A + \mu_A^V) A$$


$$\frac{dS_V}{dt} = \epsilon_A A - \lambda^{h \rightarrow V} - \mu_V^V S_V$$

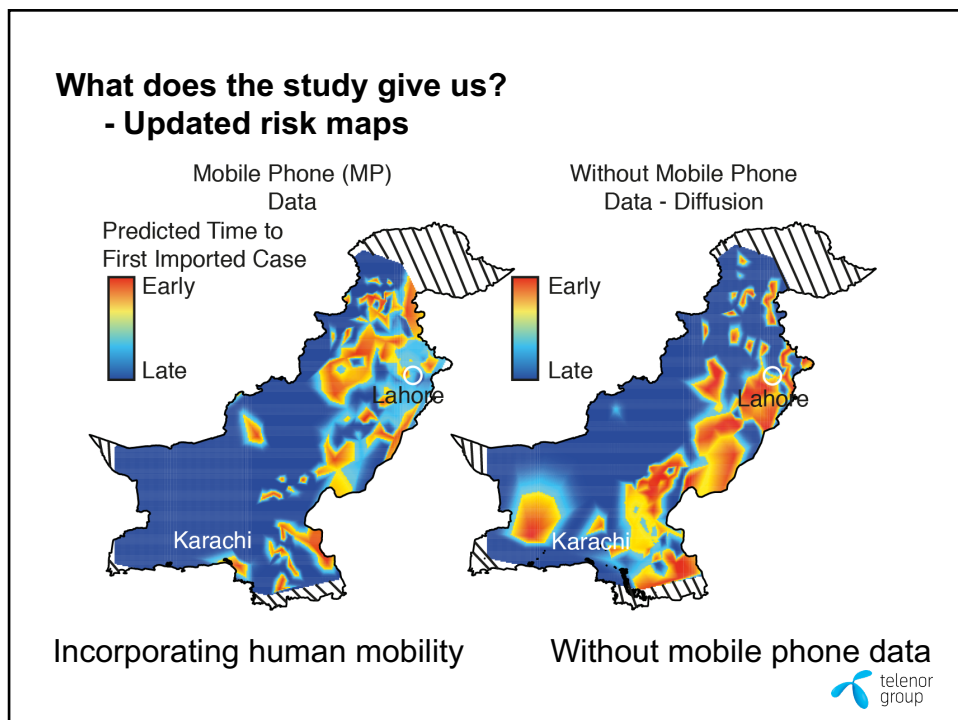
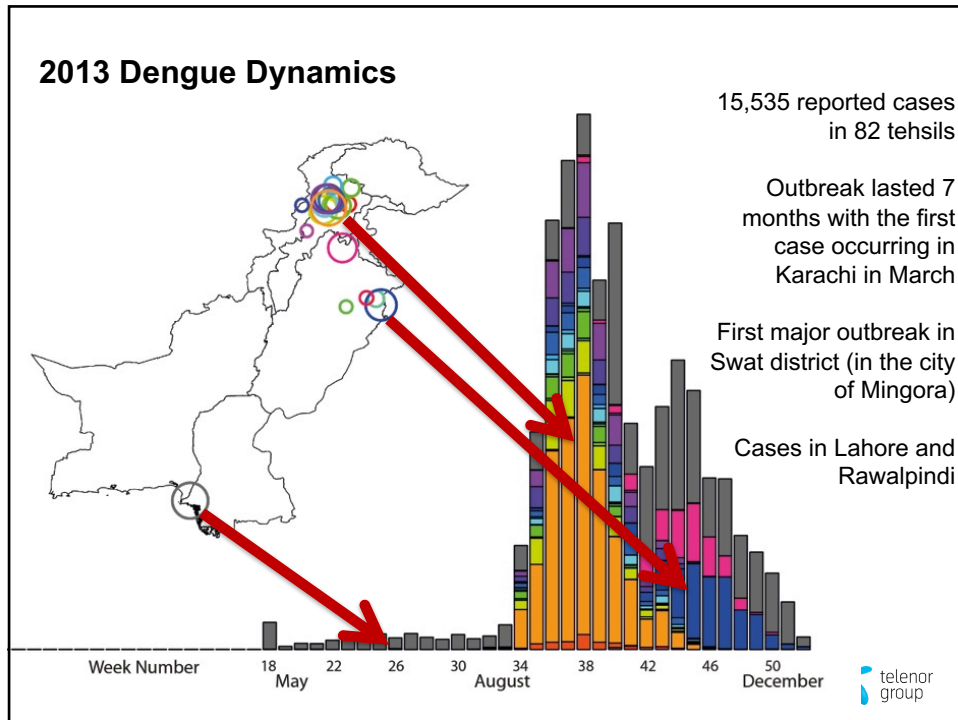
$$\frac{dE_V}{dt} = \lambda^{h \rightarrow V} - \gamma_V^V E_V - \mu_V^V E_V$$

$$\frac{dI_V}{dt} = \gamma_V^V E_V - \mu_V^V I_V$$

$$V = S_V + E_V + I_V.$$

30

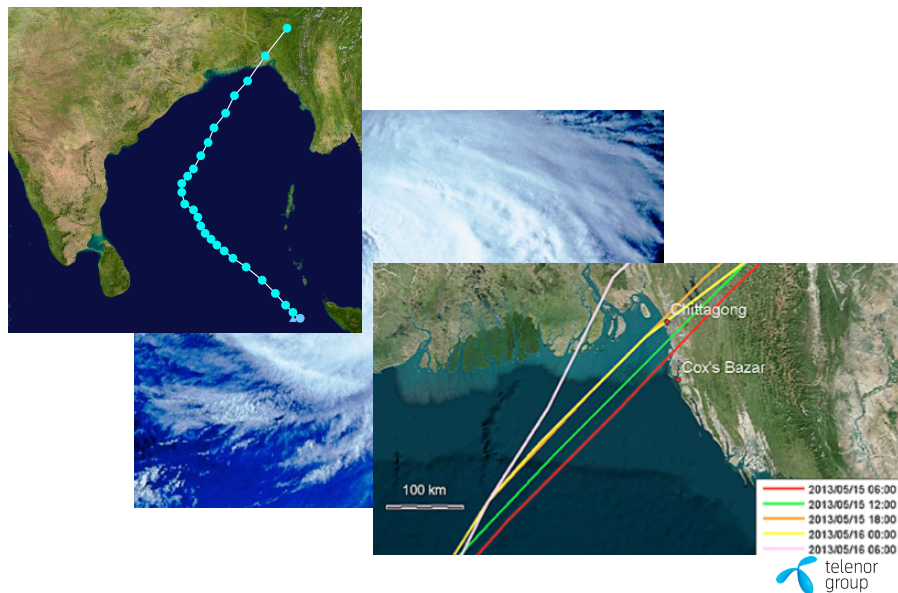




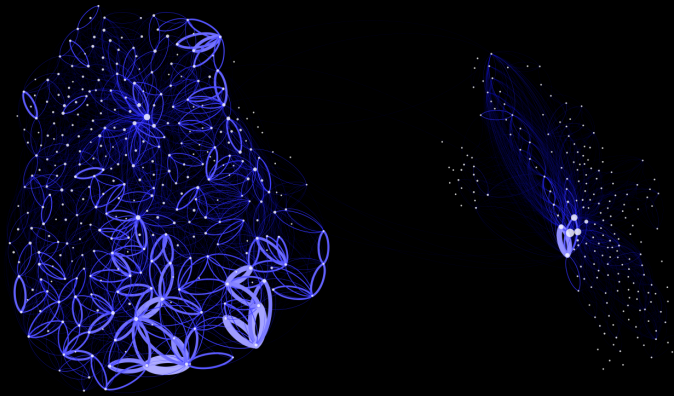
Mobility and cyclones



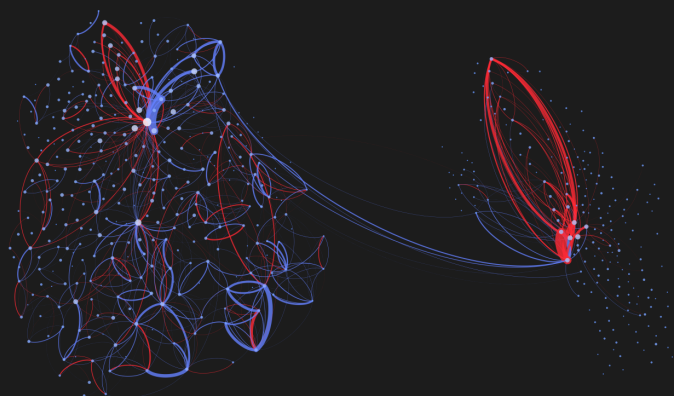
Cyclone Mahasen: 16 May 2013



Normal Mobility

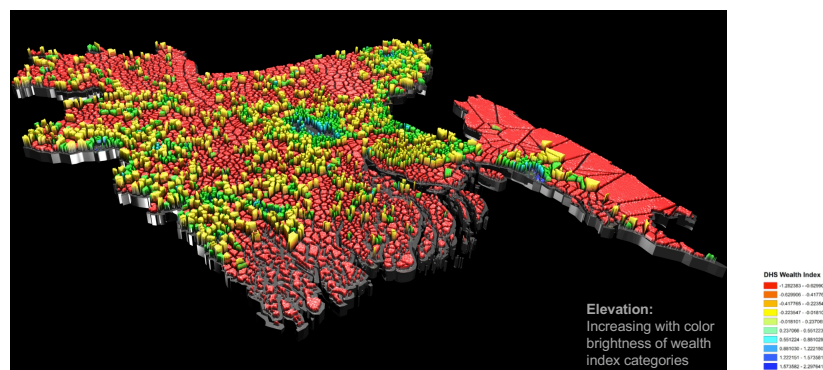


Evacuation



During the Cyclone

Mapping poverty using mobile phone and satellite data





Telenor Group Privacy Framework

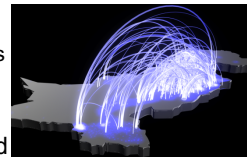


Privacy and confidentiality in the dengue project

We follow the guidelines in the Telenor Privacy Toolbox developed by the Telenor Group

For Pakistan there were additional considerations:

- Parties involved needed to be under Non-Disclosure Agreements
- All personal information (CDRs) to be processed within the data warehouse and on location in Islamabad, Pakistan
- Only Telenor personnel to process the CDRs
- No personal information was exported out of Pakistan
- The results of the processing were anonymous summations/aggregations that represent the mobility patterns of large groups of people



Only anonymous, aggregate data was used in the study and the epidemic modeling of dengue spreading



The greater context

Challenges:

- Infectious diseases:
 - Dengue, malaria, chikungunya, measles, etc
- Disasters due to cyclones and flooding
- Earth quakes

Cambodia:

- Drug-resistant malaria believed to originate in Cambodia.



