Time Accuracy of Post-Mediation Packet-Switched Charging Data Records for Urban Mobility Applications

Oscar Peredo and Romain Deschamps

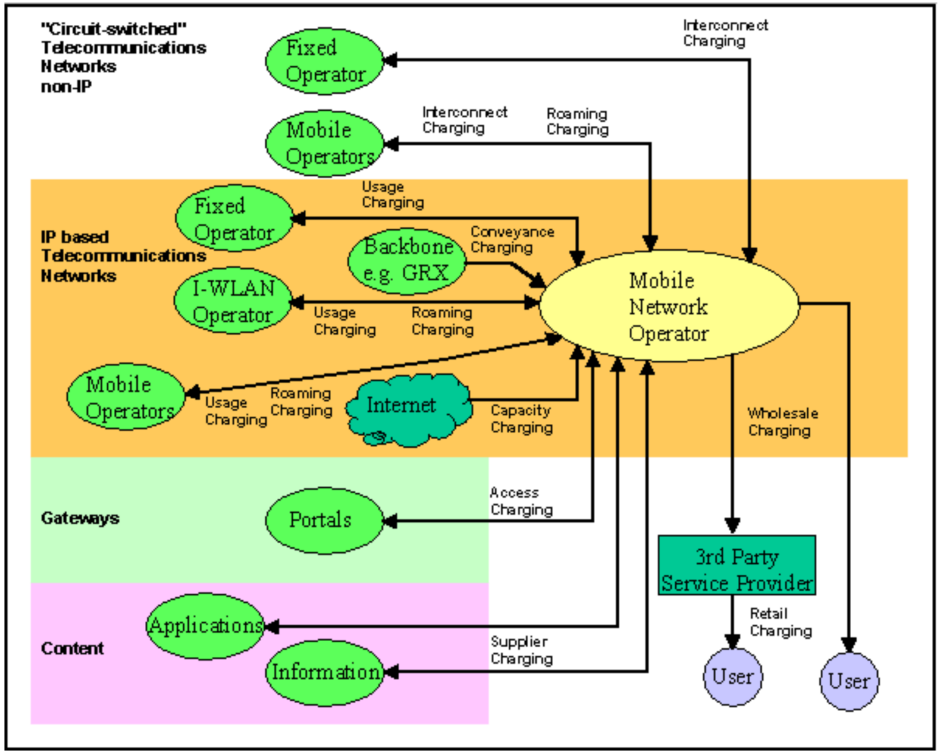
NetMob 2017, 5-7 April, Milano, Italy

Packet Switched Network

3GPP TS 22.115 V12.3.0 (2015-03)

Technical Specification

3rd Generation Partnership Project;
Technical Specification Group Services and System Aspects;
Service aspects;
Charging and billing
(Release 12)



http://www.arib.or.jp/english/html/overview/doc/STD-T63v11_00/5_Appendix/Rel12/22/22115-c30.pdf

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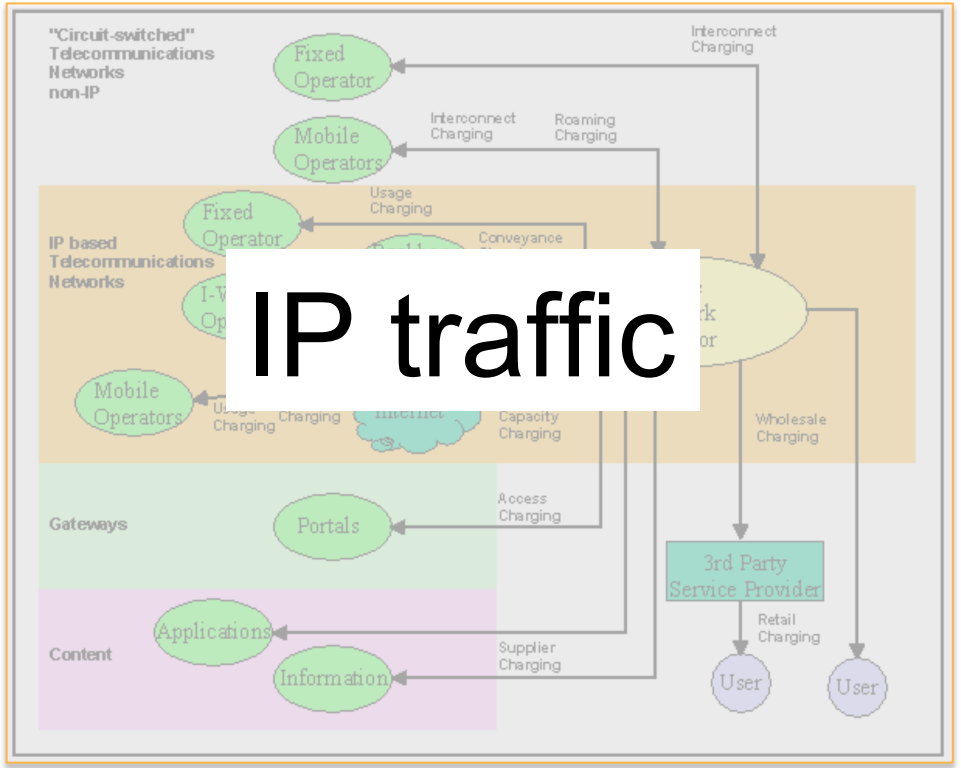
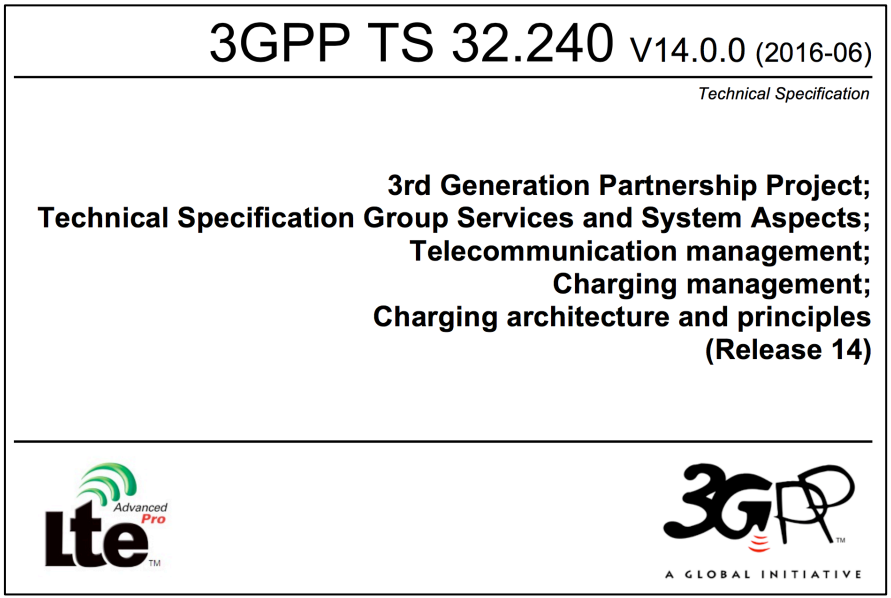


IP traffic

http://www.arib.or.jp/english/html/overview/doc/STD-T63v11_00/5_Appendix/Rel12/22/22115-c30.pdf

Charging Data Records (CDR)



3GPP TS 32.240 V14.0.0 (2016-06)

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Telecommunication management;
Charging management;
Charging architecture and principles
(Release 14)

LTE Advanced Pro

3GPP A GLOBAL INITIATIVE

Definition (chargeable event):

Activity utilizing telecommunications network resources and related services for:

1. user to user communication (e.g. a single call, **a data communication session** or a short message); or
2. user to network communication (e.g. service profile administration); or
3. inter-network communication (e.g. transferring calls, signalling, short messages, interconnection); or
4. mobility (e.g. roaming or inter-system handover); or
5. user to application/service communication ;

that the network operator may want to charge for.

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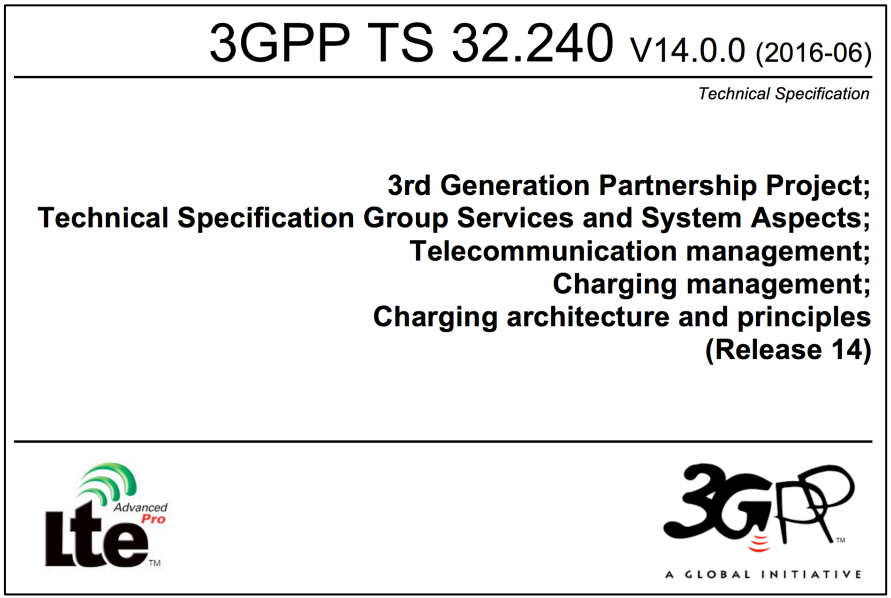
http://www.3gpp.org/ftp/tsg_sa/WG5_TM/TSGS5_107/SA_72%20input/specs/32240-e00.doc

Charging Data Records (CDR)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LTE Advanced Pro

3GPP A GLOBAL INITIATIVE

Definition (charging data record):

Formatted collection of information about a **chargeable event** for use in billing and accounting. For each party to be charged for parts of or all charges of a chargeable event a separate CDR is generated, i.e. **more than one CDR may be generated for a single chargeable event**, e.g. because of its long duration, or because more than one charged party is to be charged.

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Charging Architecture

3GPP TS 32.240 V14.0.0 (2016-06)

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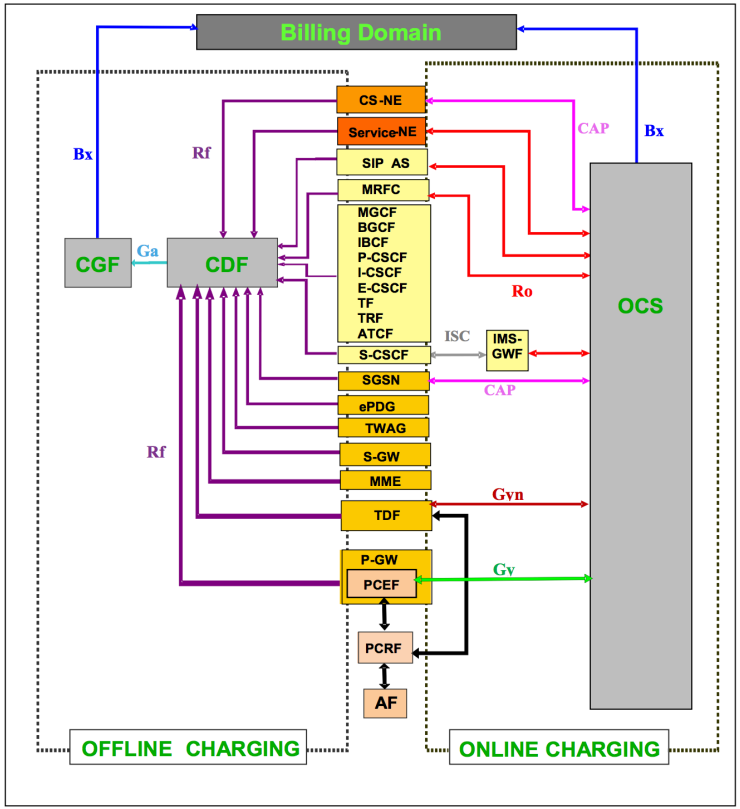

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Charging Architecture

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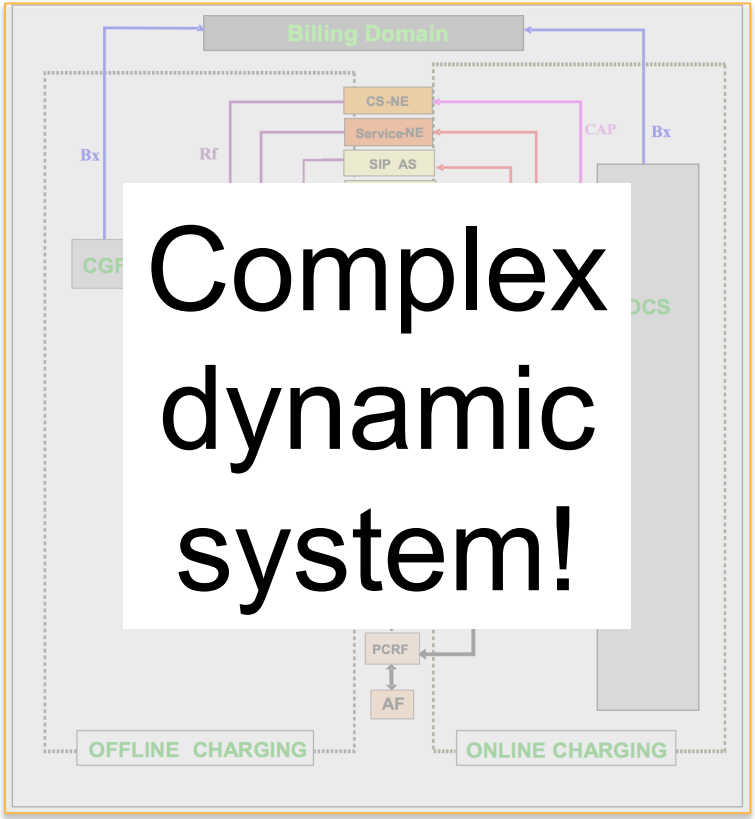
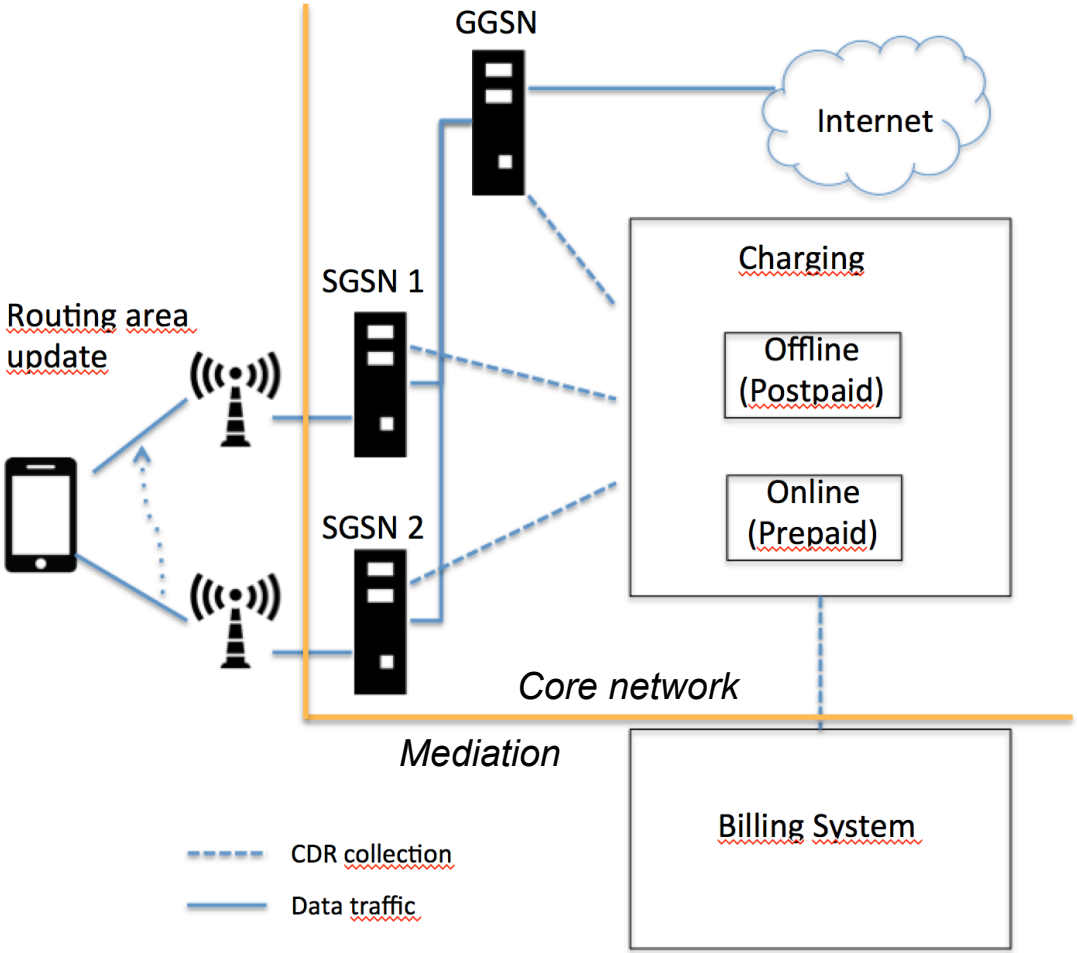


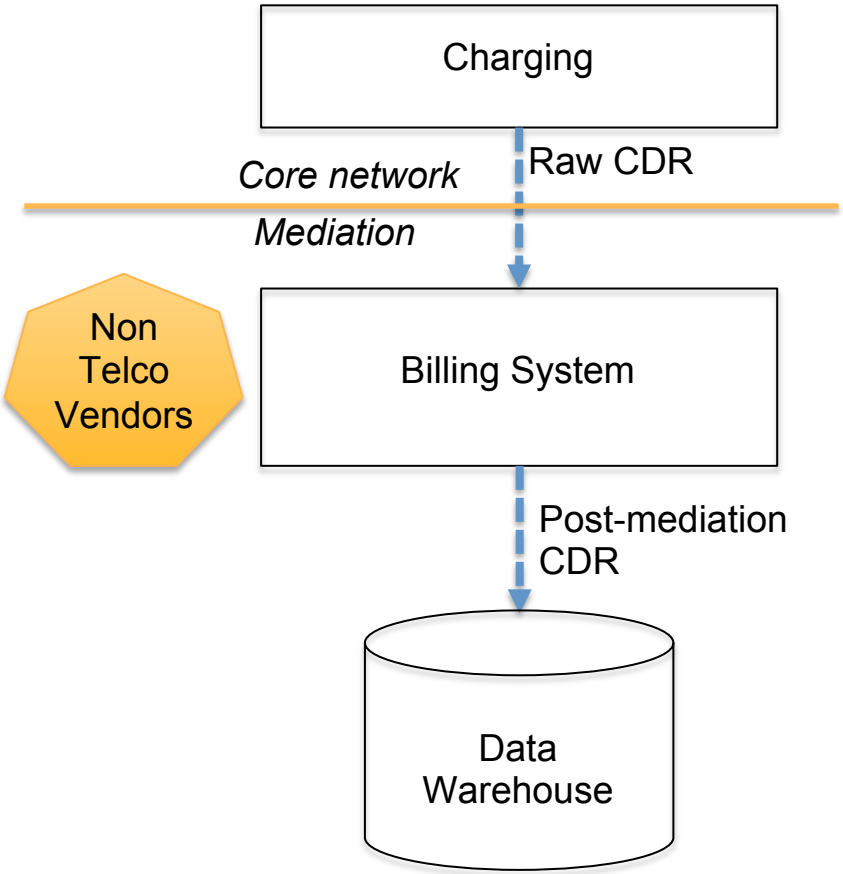
Complex dynamic system!

http://www.3gpp.org/ftp/tsg_sa/WG5_TM/TSGS5_107/SA_72%20input/specs/32240-e00.doc

A simplified charging diagram…



Raw CDRs are generated inside the core network (SSGN,GGSN,…) and collected by charging systems according to the subscriber contract



In a next stage, raw CDR are processed by a billing system (aggregation/filtering/business rules)

Finally, the post-mediation CDR are stored in a DW

size(PM CDR) << size(Raw CDR)

Empirical study of PS PM CDR accuracy

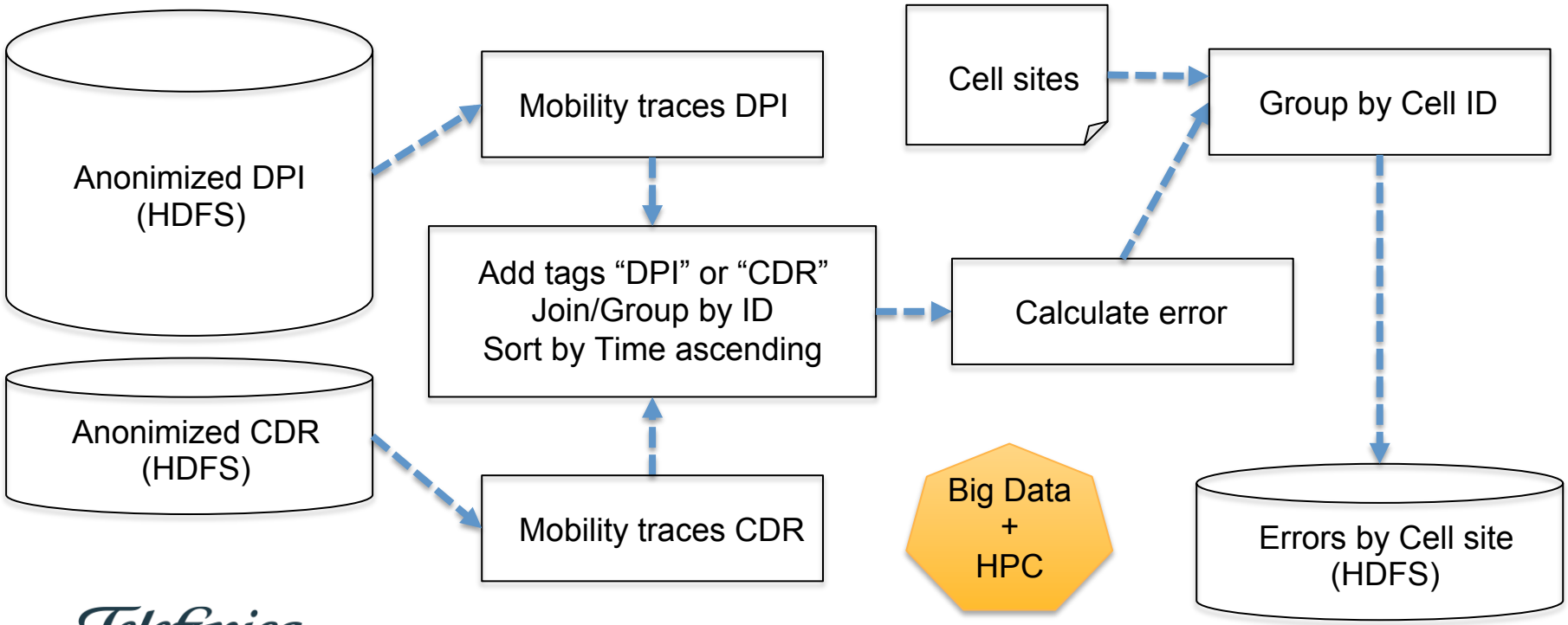
Data and error estimates

- **Subscribers**: ~7 million of anonimized subscribers
- **Cells**: ~40000 cell sectors (almost all Chilean cities)
- **CDR**: ~100 million mobility registers (time,cell ID) daily
- **DPI (IP usage)**: ~5000 million mobility registers (time, cell ID) daily

The error between a CDR and DPI event is calculated as:

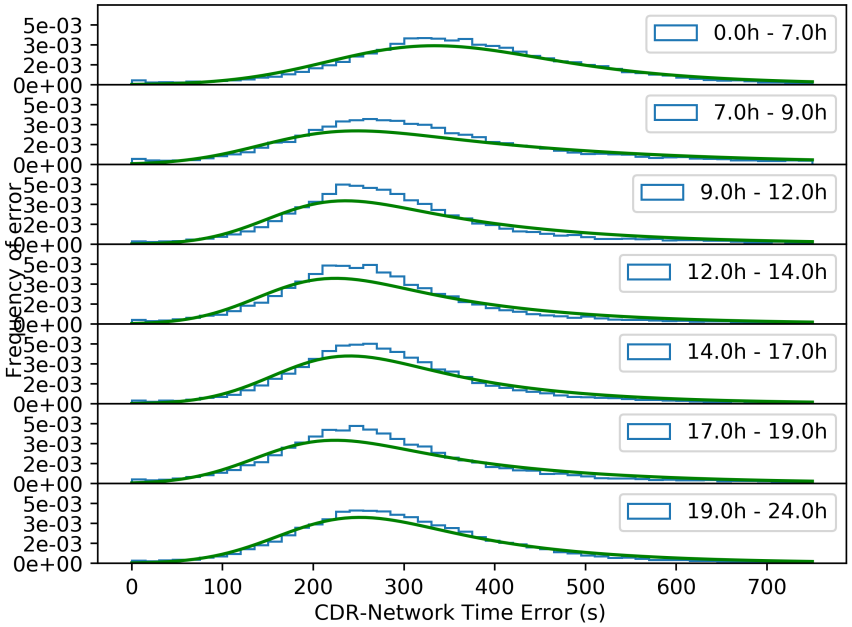
- **Error(i)** := t_i^{CDR}-t_j^{DPI} s.t. $cell_i^{CDR}$=$cell_j^{DPI}$, j := $argmin_{k<i}(t_i^{CDR}-t_k^{DPI})$
- “Difference in time between the current CDR and the last DPI event registered in the same cell”

Computational resources



Daily error variability (May 10th, 2016)

3G, postpaid



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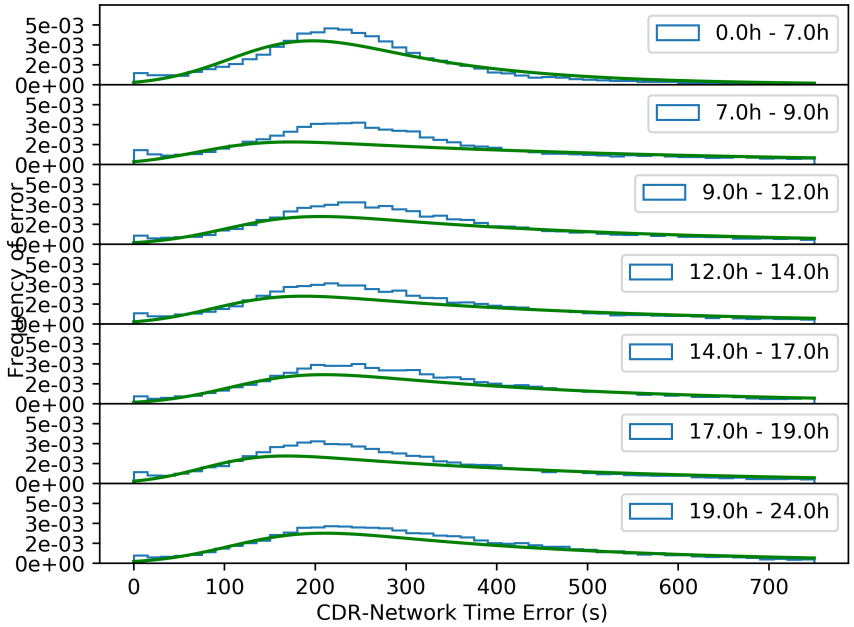

All cell sites with 3G technology

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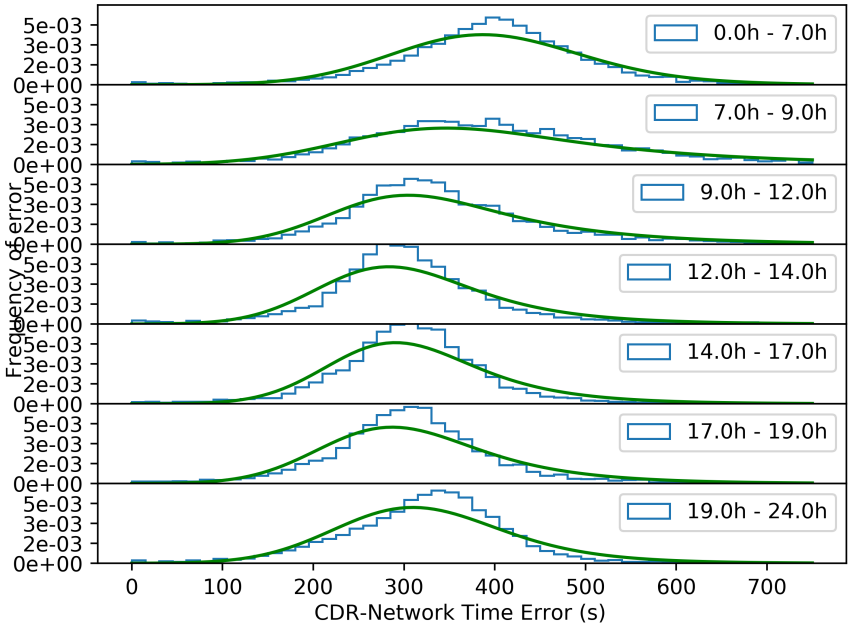
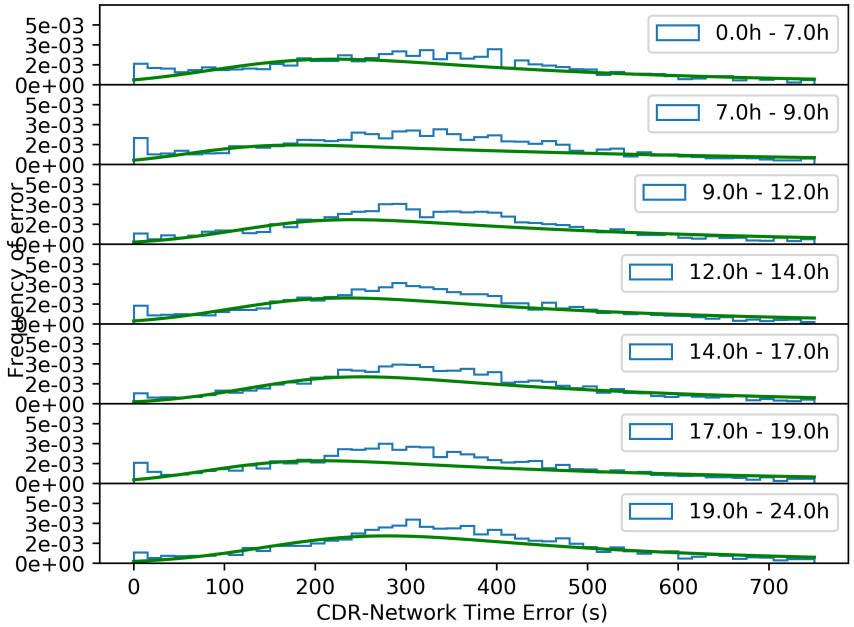
Daily error variability (May 10th, 2016)

4G, postpaid



4G, prepaid



All cell sites with 4G technology

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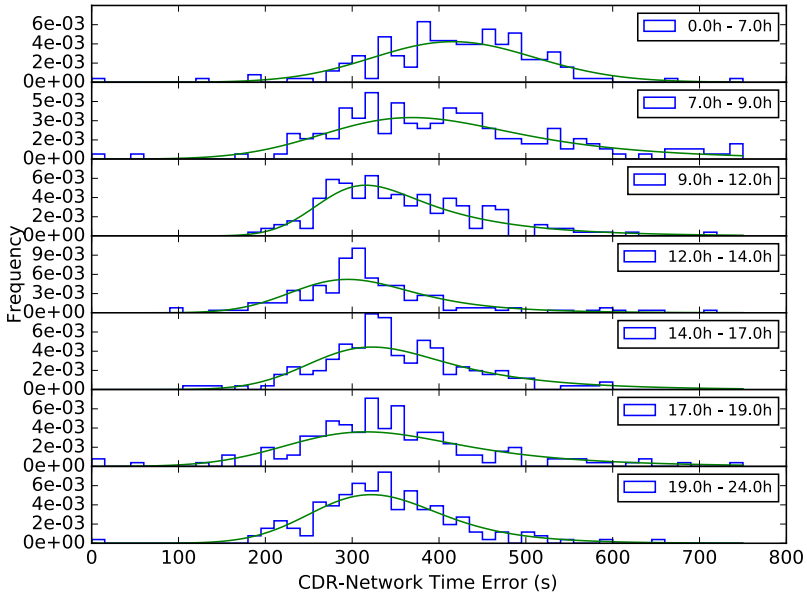
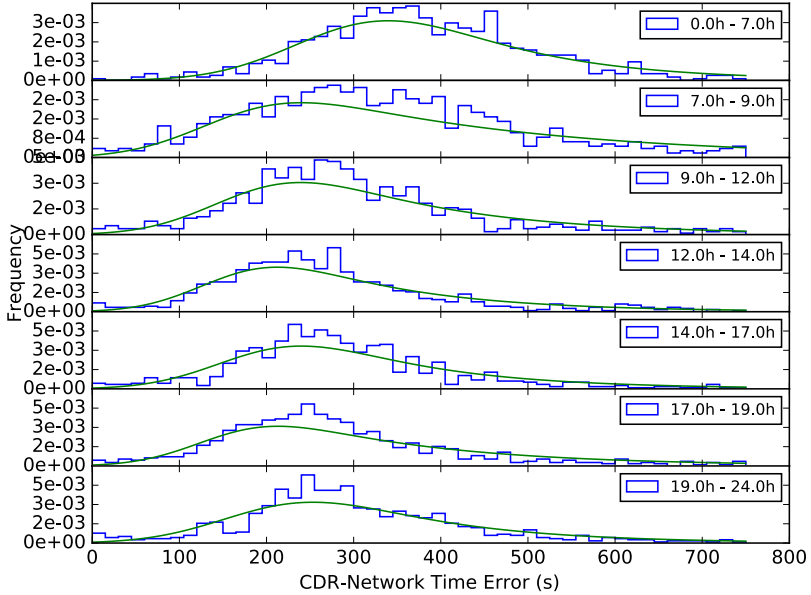


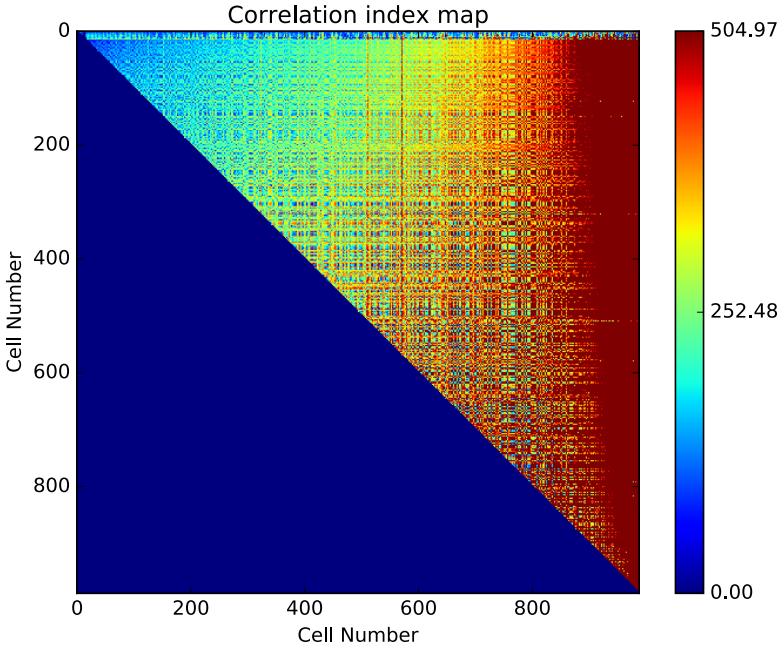
4G, postpaid



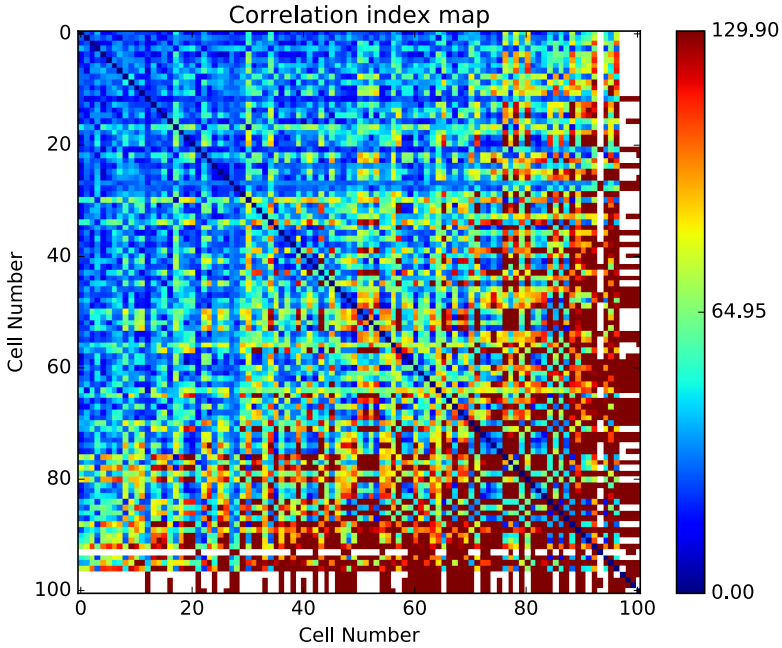
Only cell sites located in a mid-size city

Cell-Cell Correlation matrix (May 10th, 2016)

1000 cell sites



100 random cell sites



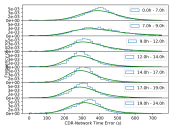
Groups of cell sites with similar behavior

Conclusions & future work

- PS PM CDR are already being collected by the Telcos, and its volume is an order of magnitude higher than voice CDR.

- If an error estimate can be obtained, and we can identify which days are “normal”, a multi-variate error model can be inferred.

- $[t_i^{CDR}]^* := t_i^{CDR} - error(hour_i, cell_{CDR}, contract_{CDR}, city_{CDR}, \ldots)$ where

$$error \sim F\left(\right.$$  $$\left. \right)$$

- Researchers/applications can use the error model to increase the accuracy of urban studies obtained from this dataset.

Thank you!

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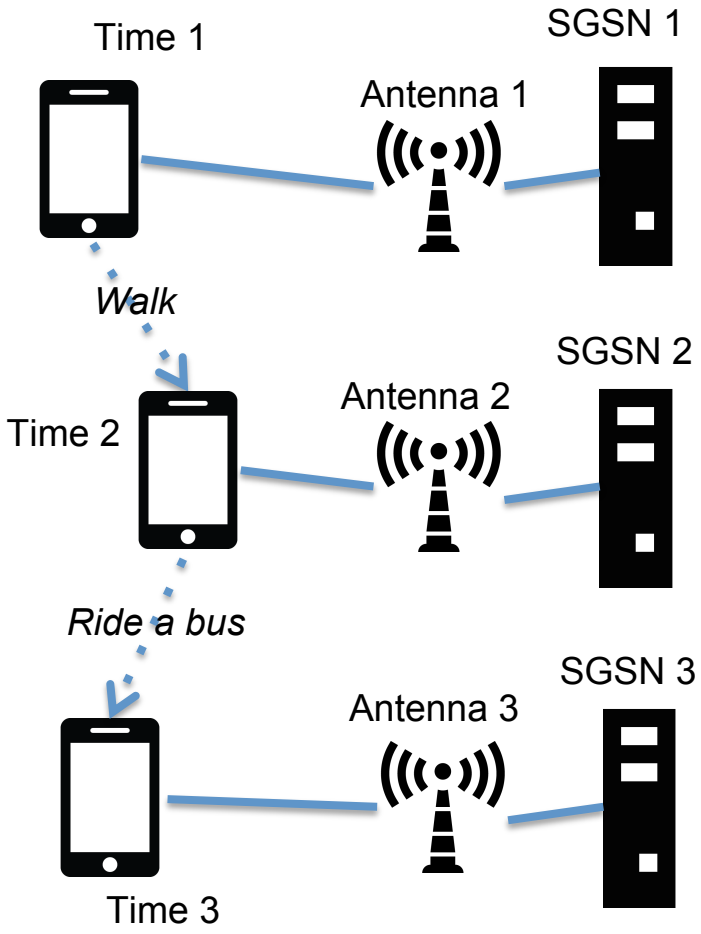
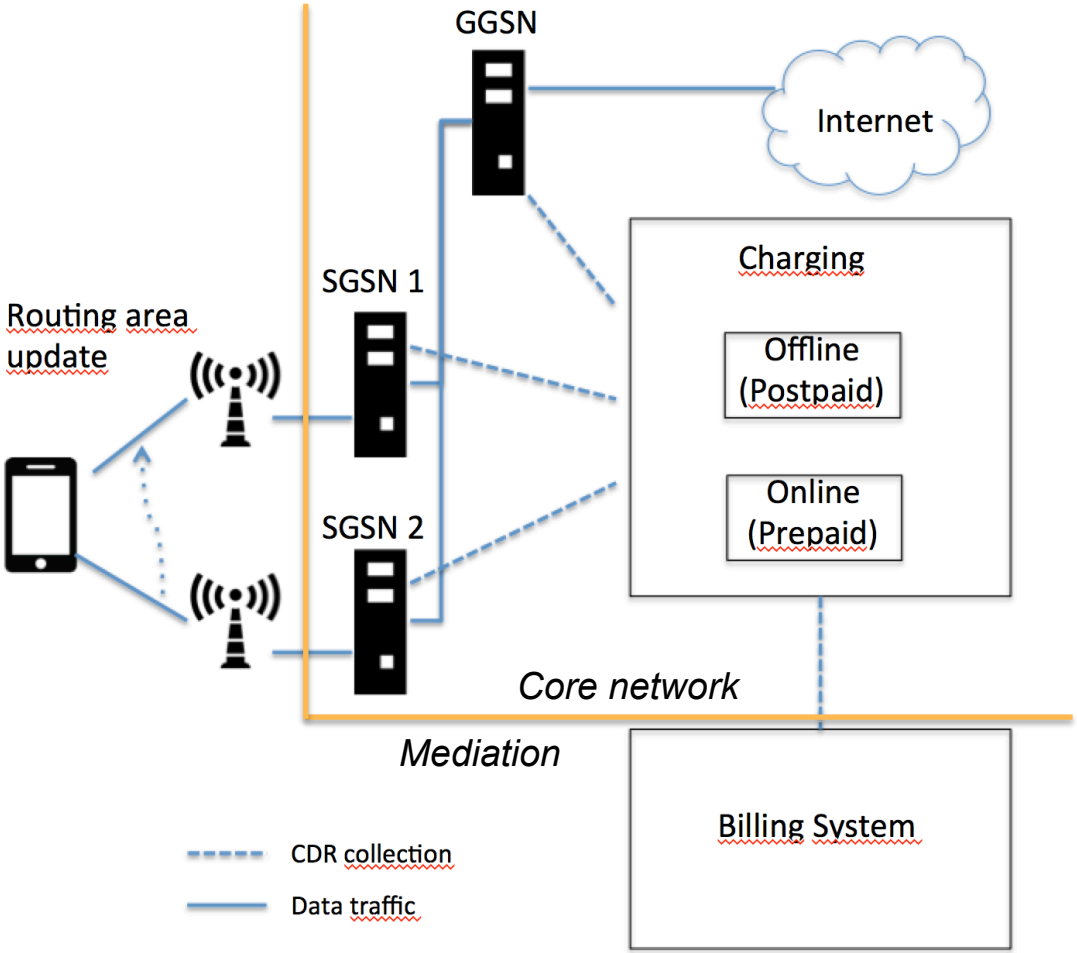


If you are playing a Youtube video in your mobile phone, passing through 3 different antennas (in different SGSN areas),

which timestamp and cell ID must be used in the post-mediation CDR?



S-CDR
SGW-CDR
ePDG-CDR
PGW-CDR
M-CDR
S-SMO-CDR
SMS-SMT-CDR
LCS-MO-CDR
LCS-MT-CDR
LCS-NI-CDR
…

Raw CDR sample (2G/3G SGSN)

ASN.1 format

```
*****************************************************************
cdr.recordType = sgsnPDPRecord
cdr.servedIMSI = 73007029XXXXXXX
cdr.servedIMEI = 0x532919506XXXXXXX
cdr.servedMSISDN = 5695XXXXXXX
cdr.sgsnAddress.iPBinaryAddress.iPBinV4Address = 66.201.XXX.YYY
cdr.chargingID = 1675505650
cdr.ggsnAddressUsed.iPBinaryAddress.iPBinV4Address = 66.201.WWW.ZZZ
cdr.apnSelectionMode = mSorNetworkProvidedSubscriptionVerified
cdr.pdpType = 0xf121
cdr.servedPDPAddress.iPAddress.iPBinaryAddress.iPBinV4Address = 10.9.A.B
…
cdr.rATType = UTRAN (1)
cdr.recordOpeningTime = 16-04-14 11.37.34 -0300
cdr.duration = 123
cdr.causeForRecClosing = servingNodeChange
cdr.listOfTrafficVolumes.[0].dataVolumeGPRSUplink = 55901
cdr.listOfTrafficVolumes.[0].dataVolumeGPRSDownlink = 124175
cdr.listOfTrafficVolumes.[0].changeTime = 16-04-14 11.39.37 -0300
cdr.routingArea = 0xc3
cdr.locationAreaCode = 0x0bb8
cdr.cellIdentifier = 0x7531
…
*****************************************************************
```

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```
**********************************************************************
cdr.recordType = sgsnPDPRecord
cdr.servedIMSI = 73007029XXXXXXX
cdr.servedIMEI = 0x532919506XXXXXXX
cdr.servedMSISDN = 5695XXXXXXX
cdr.sgsnAddress.iPBinaryAddress.iPBinV4Address = 66.201.XXX.YYY
cdr.chargingID = 1675505650
cdr.ggsnAddressUsed.iPBinaryAddress.iPBinV4Address = 66.201.WWW.ZZZ
cdr.apnSelectionMode = mSorNetworkProvidedSubscriptionVerified
cdr.pdpType = 0xf121
cdr.servedPDPAddress.iPAddress.iPBinaryAddress.iPBinV4Address = 10.9.A.B
...
cdr.rATType = UTRAN (1)
cdr.recordOpeningTime = 16-04-14 11.37.34 -0300
cdr.duration = 123
cdr.causeForRecClosing = servingNodeChange
cdr.listOfTrafficVolumes.[0].dataVolumeGPRSUplink = 55901
cdr.listOfTrafficVolumes.[0].dataVolumeGPRSDownlink = 124175
cdr.listOfTrafficVolumes.[0].changeTime = 16-04-14 11.39.37 -0300
cdr.routingArea = 0xc3
cdr.locationAreaCode = 0x0bb8
cdr.cellIdentifier = 0x7531
...
**********************************************************************
```

ASN.1 format

Raw CDR sample (2G/3G SGSN)

Records are opened/ closed registering consumed data volume

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```
cdr.recordOpeningTime = 16-04-14 11.37.34 -0300
cdr.duration = 123
cdr.causeForRecClosing = servingNodeChange
cdr.listOfTrafficVolumes.[0].dataVolumeGPRSUplink = 55901
cdr.listOfTrafficVolumes.[0].dataVolumeGPRSDownlink = 124175
cdr.listOfTrafficVolumes.[0].changeTime = 16-04-14 11.39.37 -0300
cdr.routingArea = 0xc3
cdr.locationAreaCode = 0x0bb8
cdr.cellIdentifier = 0x7531
```

```
causeForRecClosing = {
    normalRelease,              abnormalRelease,
    volumeLimit,                timeLimit,
    servingNodeChange,          maxChangeCond,
    rATChange,                  mSTimeZoneChange,
    sGSNPLMNIDChange,           managementInitRelease,
    creditControlChange,        creditControlInitRelease,
    policyControlInitRelease
}
```

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Raw CDR sample (2G/3G SGSN)

Records are opened/ closed registering consumed data volume

Many reasons to be closed…

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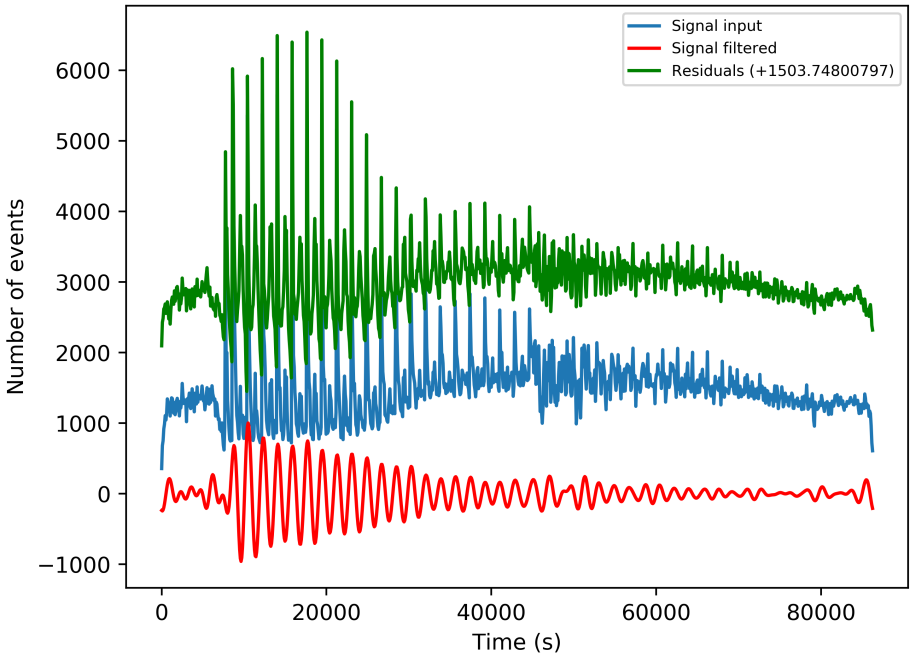
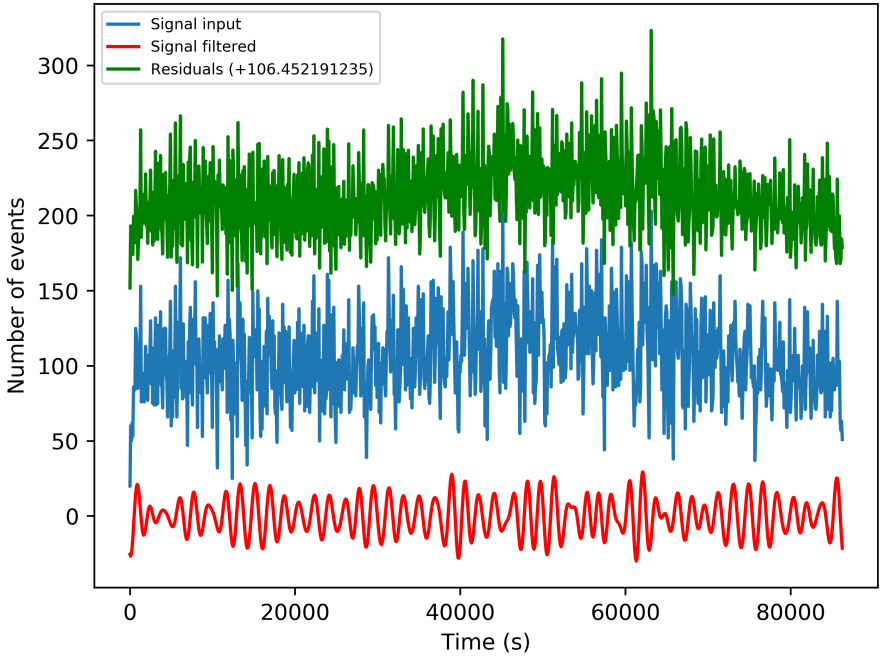

Signal input
Signal filtered
Residuals (+1503.74800797)
Number of events
Time (s)
6000
5000
4000
3000
2000
1000
0
−1000
0
20000
40000
60000
80000


Signal input
Signal filtered
Residuals (+106.452191235)
Number of events
Time (s)
300
250
200
150
100
50
0
0
20000
40000
60000
80000