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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Cloud Computing

Big-data-driven networking – mobile network traffic management and planning

Recommendation ITU-T Y.3651

International Telecommunication Union

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Recommendation ITU-T Y.3651

Big-data-driven networking – mobile network traffic management and planning

Summary

In a mobile network, a great deal of traffic data which reflects the real status of the mobile network and customers' actual experience is generated all the time. Based on the big data generated from the mobile network more efficient management and reasonable planning of mobile networks can be achieved.

In order to study related content, Recommendation ITU-T Y.3651 specifies some technology aspects related to big-data-driven networking – mobile network traffic management and planning. The scope of this Recommendation includes: requirements, framework, reference points, performance aspects and security considerations of big-data-driven networking – mobile network traffic management and planning.

History

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bDDN, mobile network traffic management, mobile network planning

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

This Recommendation specifies some technology aspects related to big-data-driven networking – mobile network traffic management and planning. The scope of this Recommendation includes: requirements, framework, reference points, performance and security considerations of big-data-driven networking – mobile network traffic management and planning.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.2770] Recommendation ITU-T Y.2770 (2012), *Requirements for deep packet inspection in next generation networks.*

[ITU-T Y.2771] Recommendation ITU-T Y.2771 (2014), *Framework for deep packet inspection.*

[ITU-T Y.3650] Recommendation ITU-T Y.3650 (2018), *Framework of big-data-driven networking.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 big-data-driven networking (bDDN) [ITU-T Y.3650]: Big-data-driven networking (bDDN) is a type of future network framework that collects big data from networks and applications, and generates big data intelligence based on the big data; it then provides big data intelligence to facilitate smarter and autonomous network management, operation, control, optimization and security, etc.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

2G Second Generation

3G Third Generation

4G Fourth Generation

API Application Programming Interface

bDDN	big-Data-Driven Networking
BSS	Business Support System
CM	Configuration Management
CN	Core Network
CS	Circuit Switch
DPI	Deep Packet Inspection
GIS	Geographic Information System
GPRS	General Packet Radio Service
HTTP	Hypertext Transfer Protocol
IM	Instant Message
IMSI	International Mobile Subscriber Identity
MME	Mobility Management Entity
MNO	Mobile Network Operator
MR	Measurement Report
MSC	Mobile Switching Centre
MSISDN	Mobile Station International ISDN Number
PM	Performance Management
PS	Packet Switch
QoS	Quality of Service
RAN	Radio Access Network
RSCP	Received Signal Code Power
RSRP	Reference Signal Receiving Power
RSRQ	Reference Signal Receiving Quality
UE	User Equipment

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

6 Introduction

With the rapid development of mobile networks, customers who are acting as both users of mobile networks and generators of big data in mobile networks, are more and more sensitive to the quality of the mobile network. Mobile network operators (MNOs) need to enhance the traffic management, the sense of the experience of service provided for customers and accelerate the construction of mobile networks in areas which are short of network resources.

Currently, MNOs are mostly achieving mobile network management by decentralized network management equipment. They can only monitor the volume of traffic which is carried on base

stations in limited areas, but cannot monitor the whole base stations in one point. Also through the common network management equipment, they cannot know which service generates the traffic and who uses the traffic. In conclusion, the existing methods cannot fully understand the whole situation of a mobile network. In addition, they are unproductive and inefficient at analysing the traffic.

In mobile network planning, traditional methods generally calculate the quantity and capacity of base stations according to the population size of an area and the corresponding measurement of traffic, choosing the base station location according to the drive test results and customers' complaint records. They seldom take the customers' actual experience in using services into consideration. This causes the problematic impression that the mobile network is sufficient as a whole, but in short supply in some areas. Briefly, the existing mobile network planning methods are unable to ensure the veracity and validity required for mobile network construction.

In the mobile network, a great deal of traffic data both in the user and in the signal plane is generated all the time, which reflects the real status of mobile network itself and customers' actual experience when they are using services. Based on this information, more efficient management and reasonable planning of mobile networks could be achieved.

Therefore, the question of how to drive mobile network traffic management and planning using big data related technologies should be considered.

7 Requirements of big-data-driven networking - mobile network traffic management

In a mobile network, a great deal of traffic data is generated all the time. This data includes information related to users' behaviours, network control processes and the status of the network. By collecting and analysing big data, information the running status and real utilization of the mobile network itself and even users' real service experiences can be obtained. In addition, driven by this information mining from big data, comprehensive and efficient traffic management for the mobile network can be achieved. This clause specifies the requirements of big-data-driven networking – mobile network traffic management.

7.1 Data categories

There are three categories for the data needed to be collected from the mobile network:

– Signal data

– Users' behaviour data

– Common parameter data

7.1.1 Signal data

The signal data transfers over the mobile network, records the control processes and reflects the running status of the mobile network.

Signal data comprises two aspects; signal data in the radio access network (RAN) and signal data in the control plane of the core network (CN).

7.1.2 Users' behaviour data

The users' behaviour data reveals the users' actual behaviour in the mobile network. This data provides insight into the true experience when users enjoy a service in the mobile network. The users' behaviour data is collected from the user plane of the CN.

7.1.3 Common parameter data

The common parameter data is the data representing the information of base stations and cells in the mobile network, describing the application information and the users' information. It can be correlated with the users' behaviour data and the signal data.

7.2 Requirements related to data categories

The scopes and sources for different categories of data are required as follows:

7.2.1 Signal data

7.2.1.1 Signal data in the RAN

There are three types of signal data in the RAN. They can be collected from network management and control elements.

1) Performance Measurement (PM) data

PM data records performance information of a mobile network.

It is recommended to collect the PM data, such as call drop rate, handover success rate and so on.

Details about PM data can be found in [b-3GPP TS32.401].

2) Configuration management (CM) data

CM data records configuration information of a mobile network. It is helpful for providing overview information on a mobile network.

It is recommended to collect CM data.

Details about CM data can be found in [b-3GPP TS32.106].

3) Measurement report (MR) data

MR data measures the intensity and quality of current serving or neighbouring cells, reported to the mobile network by user equipment (UE).

It is required to collect MR data, including reference signal receiving power (RSRP) and reference signal receiving quality (RSRQ) data.

Details about the MR data can be found in [b-3GPP TS25.111].

7.2.1.2 Signal data in the core network

The signal data in the core network is collected from the control plane and scatters into different interfaces as shown in Figure 7-1.

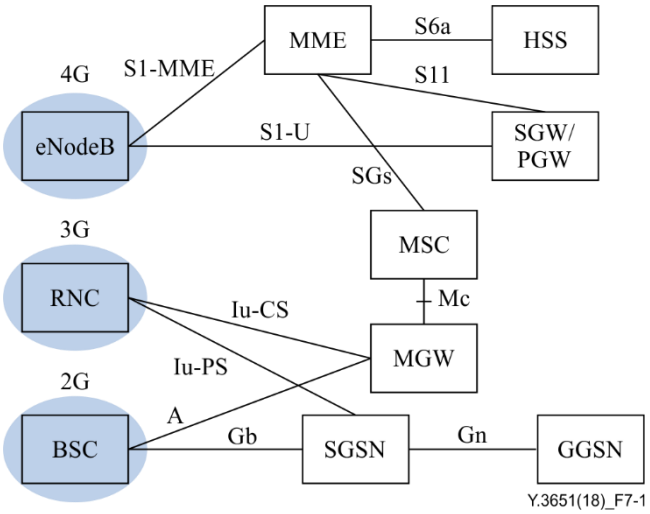


Figure 7-1 – Interfaces between network elements in mobile network

– For second generation (2G) networks, it is required to collect signal data from interface A [b-3GPP TS43.903] and from interface Gb [b-3GPP TS29.060].

– For third generation (3G) networks, it is required to collect signal data from interface Iu-CS [b-3GPP TS25.410] and interface Iu-PS [b-3GPP TS25.410].
– For fourth generation (4G) networks, it is required to collect signal data from interface S1-MME [b-3GPP TS36.413], interface S6a [b-3GPP TS29.272], interface SGs [b-3GPP TS29.118] and interface S10 [b-3GPP TS29.274].

It is required that collected signal data in CN includes but is not limited to: who are the users, the network type (2/3/4G), the location in the mobile network (which cell), the signalling procedure type, the start and end time of the signalling procedure, the time delay of the signalling procedure, the result of the signalling procedure (success or fail) and the reason why if the signalling procedure fails.

7.2.2 Users' behaviour data

It is required to choose main services both in packet switch (PS) and circuit switch (CS) domains to monitor the users' behaviour.

For the PS domain the data is collected through the Gn/S1-U interface [b-3GPP TS29.060] and the S1-U interface [b-3GPP TS36.413], including but not limited to: who are the users, when, where and what they are doing on the Internet, how much traffic they consume and what the result is.

For the CS domain the data is collected through a mobile switching centre (MSC) in CN, including but not limited to: who are the users, when, where and to whom they are using voice call, how long the voice call lasts and what the result is.

7.2.3 Common parameter data

7.2.2.1 Common parameters in networks

Common parameter data in networks mainly includes the distribution of base transceiver stations and cell key parameters. Users' behaviour data and signal data should be computed for every cell according to a set of indexes which can represent the running status of the mobile network. For base transceiver stations these indexes can be summarized by their own cells.

It is required to collect data items such as the cell information, the base station which the cell belongs to, the network type, the location of the base station (i.e. the longitude and the latitude of the base station or the administrative region that the base station belongs to).

7.2.2.2 Common parameters in applications

Common parameter data in applications mainly includes the classification and names of applications that users enjoy. Users' behaviour data and signal data should be computed for every application classification or popular application according to a group of indexes which can represent the service sensing. For every cell or base transceiver station these indexes can be summarized by users' accesses.

7.2.2.3 Common parameters in users

Common parameter data in users mainly includes the mobile station international ISDN number (MSISDN) and the terminals they use. The users' behaviour data and signal data should be computed for every place the MSISDN belongs to or the terminal type that users have according to a group of indexes which can represent the users' experience in the network and service. For every cell or base transceiver station these indexes can be summarized by users' accesses.

It is required to collect data items such as the user identity, the MSISDN, the international mobile subscriber identity (IMSI) and the terminal information, i.e. the terminal brand, the terminal model, the terminal operating system.

7.3 Data collection methods

There are different methods to collect different data categories.

The users' behaviour data is collected by deep packet inspection (DPI) from the Gn/S1-U interface. For information on DPI requirements, see [ITU-T Y.2770] and for information on the DPI framework, see [ITU-T Y.2771].

The signal data in the RAN is collected from network management elements through files and the signal data in CN is collected by DPI from the corresponding interfaces.

The common parameter data is collected from external databases.

7.4 Requirements for big data pre-processing

The data collected through different methods is stored in files, messages, queues or databases. Before analysis and storage, the data needs to be pre-processed. There are three stages of data pre-processing; data extraction, data transformation and data load.

In the data extraction stage, it is required to extract data from heterogeneous sources, using professional tools or application programming interfaces (APIs).

In the data transformation stage, it is required to judge the validity and integrity of data, as well as error correction aiming at certain fields, standardize data structures according to the demands of services and merge and summarize data in records and files.

In the data load stage, the data which has been pre-processed is loaded to target data warehouses.

7.5 Requirements for unified traffic management items

When the collected data has been pre-processed and stored in a big data platform, it is required to analyse a set of items for unified traffic management. There are two computing patterns; real-time steam processing and off-line batch processing. Based on the result data of these computing patterns, we can sense the quality of service (QoS) in the mobile network.

7.5.1 Real-time stream processing items

Real-time stream processing data items are required to compute all of the time for multiple dimensions for as long as the data from the mobile network is collected.

It is required, to but not limited to, process items as follows:

– Number of users

It is required to calculate the number of users registered to the mobile network and the number of users using a service in real time for multiple dimensions, such as numbers in different cells and in different base stations, numbers in different network types, numbers in different administrative regions and numbers in different network types.

– Traffic

It is required to calculate the total traffic, uplink traffic and downlink traffic in a mobile network in real-time for multiple dimensions, such as traffic in different cells, traffic in different base stations, traffic in different administrative regions, traffic in different network types, traffic of different applications and traffic of different users.

– Internet speed

It is required to calculate Internet speed in a mobile network in real-time for different dimensions, such as Internet speed of different cells, speed of different base stations, Internet speed of different administrative regions, Internet speed of different network types, speed of different applications and speed of different users.

7.5.2 Off-line batch processing items

Off-line batch processing items are required to analyse for multiple dimensions at regular intervals, such as daily, weekly, monthly and annually.

It is required to, but not limited to, process items as follows:

– Average number of users

It is required to analyse the average number of users in a mobile network offline at different intervals.

i) Average number of users registered to the mobile network

It is required to calculate the average number of mobile network registered users at different intervals in different dimensions, such as the average number of network registered users in different cells, the average number of network registered users in different base stations, the average number of network registered users in different administrative regions, the average number of network registered users of different network types and the average number of network registered users of different applications.

ii) Average number of services being used

It is required to calculate the average number of users using services at different time intervals and in the same various dimensions as for the number of users registered to the mobile network.

iii) Average number of resident users

It is required to calculate the average number of resident users at different intervals in different dimensions as the same as the mobile network registered users' number.

– Average of traffic

It is required to calculate the average of traffic, the average of download traffic, the average of upload traffic at different intervals in different dimensions, such as the average traffic in different cells, the average traffic in different base stations, the average traffic in different administrative regions, the average traffic of different network types, the average traffic of different applications and the average traffic of different users.

– Average of Internet speed

It is required to calculate the average of Internet speed in a mobile network offline at different intervals in different dimensions as the same as the average traffic.

7.5.3 QoS monitoring in mobile network

Besides calculating the traffic and speed of a mobile network, it is required to monitor the QoS according to the processed items listed in clause 7.5.2.

It is required to monitor QoS for services and services' classification, including PS domain and CS domain.

It is required to define exclusive QoS indexes and modules for every service and classification.

NOTE – For different services, the evaluating indexes of QoS are not the same. For example, the hypertext transfer protocol (HTTP) services (traffic, speed, interval between request and response, etc.), the instant message (IM) services (success rate of log on, sending and receiving messages, etc.), the streaming services (buffer time, frequency of lagging, etc.)

It is required to monitor QoS in different dimensions as the same as the average traffic.

8 Requirements of the big-data-driven networking - mobile network planning

8.1 Centralized management of base stations

8.1.1 Centralized maintenance of base stations information

It is required to gather and maintain the information of the base stations in a centralized point.

NOTE – The information is the users' behaviour data, the signal data, the common parameters data and the result data of the real-time and off-line task and the QoS sensing result.

It is required to support centralized management of information including users' behaviour data, the signal data, the common parameters data and the result data of the real-time and off-line task, and the QoS sensing result as well as adding, updating, deleting and querying of this information.

It is required to detect missing information automatically.

8.1.1.1 Requirement of information illustration

It is required to present the information in different types, including but not limited to charts, report forms and geographic information system (GIS) maps.

It is required to display the information of the base stations in different scales.

It is required to highlight the base stations in abnormal state according to the metric set in advance

8.1.2 Centralized monitoring for base stations' running status

It is required to support centralized monitoring for base stations' running status based on the information.

It is required to obtain the running status from users' behaviour data which is generated under base stations.

8.1.3 Checking abnormal base stations

It is required to check the error conditions of base stations.

It is required to check base stations and cells which are in use or not. For those that are not in use, it is required to compute lasting intervals and analyse whether they are abnormal or not.

It is required to check whether the traffic could belong to a base station or not. For traffic that could not belong to a base station, it is required to check the base station information which occurred in users' behaviour data.

It is required to manage abnormal base stations and correct their error conditions.

NOTE – The abnormal base station state mainly includes the cases of missing information, information that changes dramatically, etc.

8.2 Requirement for the planning and construction of base station

In traditional mobile network planning, the base station is usually planned according to the customer complaints and the drive test data. This data cannot reflect the customers' perception when they enjoy the mobile network service.

The signal data and the users' behaviour data collected from the mobile network, the result data of the real-time and off-line processing and the QoS sensing data reflect the status of the mobile network and the customers' perception. By taking these data into account, mobile network operators are able to make better decisions about where to construct base stations.

In addition, mobile network planning needs take the economic benefits into account. With limited resources, base stations are built in areas where they can yield more benefit priority. This can be achieved by considering user consumption information.

It is required to collect the users' personal data from a business support system (BSS), such as the users' grade, the user pricing package, etc.

With the information of the base stations, it is required able to make models that can sense the users' experience.

It is required for the models to sense the users under one base station, but it is also required to reflect the whole mobile network base on the users' experience.

It is required for the models to correlate the users' experience and the performance of the mobile network itself.

It is required for the models to take the users' grade into account.

It is recommended for the models to reflect the proportion of different types of data service.

When existing base stations cannot guarantee the demand of the users, it is required for the models to indicate the sites where the mobile network is insufficient or badly adapted.

It is required for the models to be able to calculate where and how to construct a base station to satisfy the demand of the users.

It is required for the models to be able to predict the trend of the traffic.

Based on the models that reflect the users' experience when they enjoy a mobile network service, a mobile network similar to the users' actual demands can be constructed.

8.3 Evaluating the effect of newly-built base stations

It is required to evaluate the effects of newly-built base stations.

It is required to select already operating base stations with similar locations, network types and configurations.

It is required to compare the information between the newly-built stations and the already operating base stations and draw conclusions on the effect of newly-built base stations according to reasonable models or algorithms.

It is required to support summaries of the effects of newly-built base stations in a certain area or construction period.

9 Framework of big-data-driven networking – mobile network traffic management and planning

[ITU-T Y.3650] describes the general framework of bDDN. As is shown in [ITU-T Y.3650], the bDDN framework is made up of three planes**,** the big data plane, the management plane and the network plane. The framework described in this Recommendation is based on the general framework presented in [ITU-T Y.3650]. The framework described in this Recommendation focuses on the big data plane.

The framework of big-data-driven networking – mobile network traffic management and planning is shown in Figure 9-1.

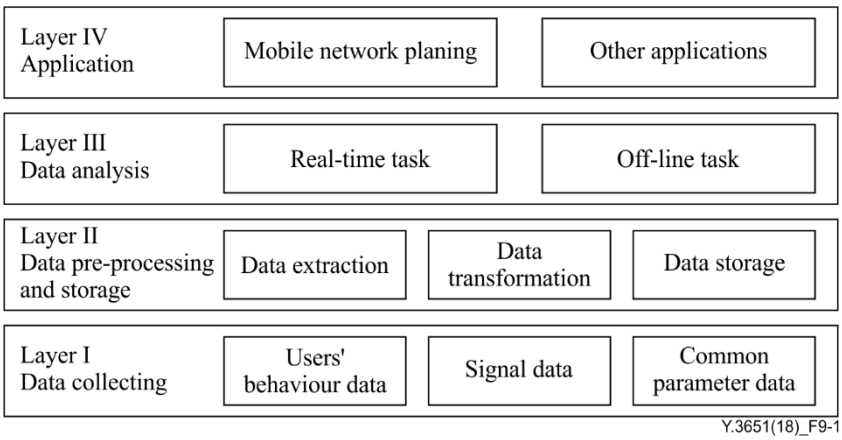


Figure 9-1 – Framework of big-data-driven networking – mobile network traffic management and planning

Layer I – Data colleting

The data collecting layer collects the signal data both in RAN and CN, the users' behaviour data and the common parameter data.

Layer II – Data pre-processing

The data pre-processing layer extracts, transforms and then loads the data to data warehouses for storage.

Layer III – Data analysis

The data analysis layer has two main tasks, the real-time task and the off-line task. The real-time task computes data items for multiple dimensions as long as the data from the mobile network is collected. The off-line task computes data items for multiple dimensions at regular intervals. Besides the real-time and the off-line task, the QoS sensing task senses the experience of mobile network users based on the result data of the real-time and off-line task.

Layer IV – Application

Many applications can be generated based on the result data of the data analysis layer. The big-data-driven networking - mobile network planning is one of these applications.

10 Reference points of big-data-driven networking – mobile network traffic management and planning

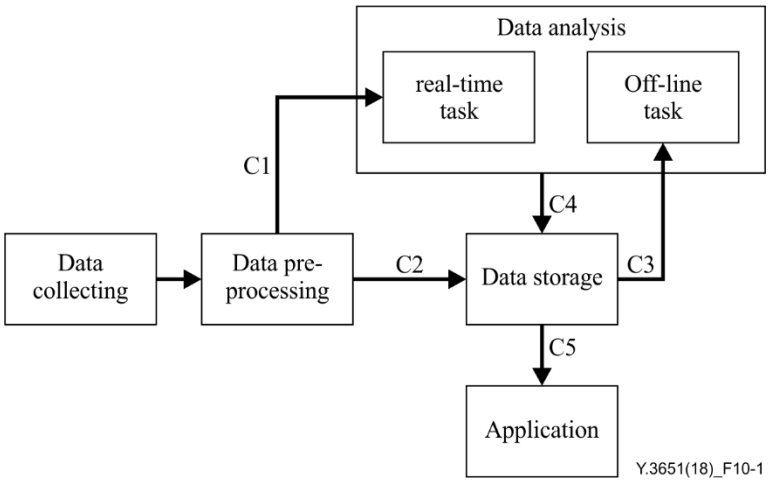


Figure 10-1 – The main reference points of big-data-driven networking – mobile network traffic management and planning

The main reference points of the big-data-driven networking – mobile network traffic management and planning system are shown in Figure 10-1, the details about the reference points are presented as follows:

– Reference point C1: After been pre-processed, the collected data is sent to message queues to compute a set of items for multiple dimensions in real time.

– Reference point C2: The pre-processed data is stored in a distributed file system for off-line computing and further operations.

– Reference point C3: The pre-processed data stored in distributed file system is sent to an off-line batch processing module to be analysed for multiple dimensions at regular intervals.

– Reference point C4: The result data of both the real-time task and the off-line task is sent to the distributed file system for storage and further operations.

– Reference point C5: The interface between the stored traffic data and applications. One of the applications, the base station management system, can detect and fulfil the loss of base station information automatically via C5.

11 Performance considerations

It is required to consider performance in the stages of data collecting, data transmission, data pre-processing, data storage and real-time data processing.

In the data collecting stage, there are some performance requirements:

– It is recommended to guarantee the completeness and accuracy rate in parsing the signal data and the users' behaviour data.

– It is recommended to guarantee the filling rate parsed records of the signal data and the users' behaviour data.

– It is recommended to guarantee the accuracy rate for users' service using information through parsing the users' behaviour data.

In the data transmission stage, there are some performance requirements.

– It is recommended to reduce the losing rate of the signal data and the users' behaviour data which is transferred from data collecting equipment to the centralized system.
– It is recommended to guarantee the timeliness for transferring data from data collecting equipment to the centralized system.

In the data pre-processing and real-time data processing stage, it is required to maintain high-throughput.

In the data storage stage, it is recommended to control the time of loading into a dataset and the number of data replications.

In the real-time data processing stage, it is recommended to consider the efficiency.

12 Security considerations

When using big-data-driven networking - mobile network traffic management and planning, security best practices should be adopted such as authentication, authorization and access control.

Appendix I

Use cases and scenarios

(This appendix does not form an integral part of this Recommendation.)

This clause describes use cases and scenarios.

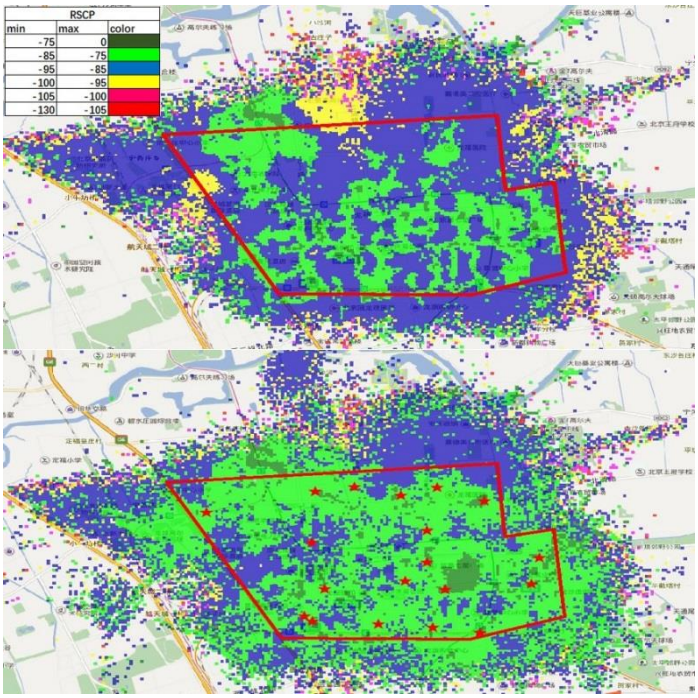
I.1 Customer journey analysis

Use case	
Name	Customer journey analysis
Description	Based on big data collected from mobile network traffic, it can support customer journey analysis. Real-time analytics that map the user journey and generates actionable insights that can allow operators to respond quickly with a "next-best offer" and convert interested prospects into customers. Data such as customer demographics and clickstreams are being combined with attributes such as location and content preferences for next best offers. This also enables commerce service providers to map specific customer's interactions with the network at various stages of the lifecycle to promote tailored offerings and campaigns.
Roles	
Figure	
Pre-conditions (optional)	
Post-conditions (optional)	
Requirements	– Users' behaviour data (refer to clause 7.2) – Real-time processing (refer to clause 7.5)

I.2 Customer churn analysis

Use case	
Name	Customer churn analysis
Description	Based on big data collected from mobile network traffic, it can support prediction of customer churn according to their quota and frequency of service using in mobile network.
Roles	
Figure	
Pre-conditions (optional)	
Post-conditions (optional)	
Requirements	– Users' behaviour data (refer to clause 7.2) – Off-line data process (refer to clause 7.5)

I.3 The evaluation and planning of the U900 base stations

Use case	
Name	The evaluation and planning of the U900 base stations
Description	The U2100 base stations are 3G base stations deployed in the 2100MHz band and the U900 are base stations deployed in the 900MHz band. The 900 can provide superior coverage compared to U2100. To evaluate the effect of the U900 in the real scenes, the MR data before and after the deployment of the U900 base stations in one particular area are collected. Figure I.1 shows the received signal code power (RSCP) before and after the deployment of the U900 base stations. In this figure, the coverage levels are distinguished by different colours. We can see that through the deployment of the U900 base stations, the coverage of the mobile network has apparently been improved. In the future construction of the mobile network, the U900 can be used to improve the coverage.
Roles	
Figure	 *Figure I.1 – The RSCP data before and after the deployment of the U900*
Pre-conditions (optional)	
Post-conditions (optional)	
Requirements	– MR data (refer to clause 7.1 and 7.2) – Information illustration (refer to clause 8.1) – Base station evaluating (refer to clause 8.3)

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