



it's about time

White Paper
Kx for Telecommunications



Content

	Page
1. Executive Summary	3
2. Telecoms industry: Solutions and Data Profiles	4 - 6
3. Sample Use Cases of Kx in the Telecoms Industry	7 - 10
2.1 Location Tracking	7
2.2 Targeted Marketing	8
2.3 Real-time Billing/ Content-Based Billing	8
2.4 Revenue Stimulation	9
2.5 SON/PCRF Automation	9 - 10
4. Telecoms Case Study: Bandwidth	11
5. About Kx Systems	12



1. Executive Summary

The Telecoms industry, like many others, has undergone massive transformation. Providing voice over fixed lines and circuit switches looks relatively simple in comparison to the labyrinth of video, text, networks, packets, routing and roaming that telecommunications companies must now manage. And at the centre of it all is a sprawling mass of data that must be managed, but more importantly, must be monetized: from CRDs to RAN DRs, from geospatial to demographics, these data sources hold opportunities and insights that companies are struggling to unlock. Kx can help them.

Kx is the world's leading time-series database. It is used widely in industries such as capital markets, insurance, finance, pharmaceutical, energy and utilities. Some of the performance metrics for Kx are shown below.

Rich Visualization – A wide range of interactive display options – heat maps, bar graphs, tree maps, candlestick graphs, pie charts, dot plots, spread graphs, advanced data filtering, sorting, paging, user configurability and others. A Dashboard Builder Wizard enables users to construct required dashboards instantaneously. An interactive environment provides immediate feedback for rapid development.

High-Volume Streaming Data – Supports hundreds of thousands of streaming records-per-second, with no degradation thanks to the power of Kx. Kx technology's ultra-low latency provides the speed necessary to deliver real-time data flow. Whether managing real-time financial tick data or real-world customer interactions, Kx data solutions ensure you never have to wait for an answer to your questions.

Subscription Mode – Optimized for streaming data, throttling and conflation by time interval and server side caching to support multiple users and achieve enterprise level scalability.

Fast Data

Single inserts, updates, joins and selects – millions per second per core. Consistent performance with 10s of billions of inserts per day

- Bulk inserts, updates, joins and selects: up to 10s of millions of bulk inserts per second. Trillions per day
- In-memory table scans of unrivalled speed measured in milliseconds across trillions of records
- Supports thousands of concurrent time-series queries involving billions of rows of data
- Publish/subscribe mechanisms which can update hundreds of subscribers or a messaging bus in real time
- Nanosecond timestamps

This paper outlines a number of use cases for Kx in the telecommunications industry. We look at the types of solutions currently provided and the different types of data that is produced. By sizing and assessing this data we identify areas where Kx can provide significant benefit. These include:

1. Location Tracking
2. Targeted Marketing
3. Real-time Billing/ Content-Based Billing
4. Revenue Stimulation
5. SON/PCRF Automation

2. Telecoms industry: Solutions and Data Profiles

Telecoms Solutions

Within telecoms there are two main types of products and solutions:

- OSS (Operating Support Systems) – products and solutions used to manage and keep the network operational, including Network Management (NM), Fault Management (FM), Performance Management (PM), Configuration Management (CM)
- BSS (Business Support Systems) – BSS deals with the taking of orders, payment issues, revenues, etc. It supports four processes: product management, order management, revenue management and customer management.

Both types are considered in this document. Historically OSS solutions were more varied (having multiple vendors) whereas BSS systems (especially CRM and Billing) tended to come only from the larger IT suppliers. The BSS domain, however, is becoming much more dynamic in order to adapt to and support the increasingly varied services and business models the industry offers. achieve enterprise level scalability.

Telecoms Data

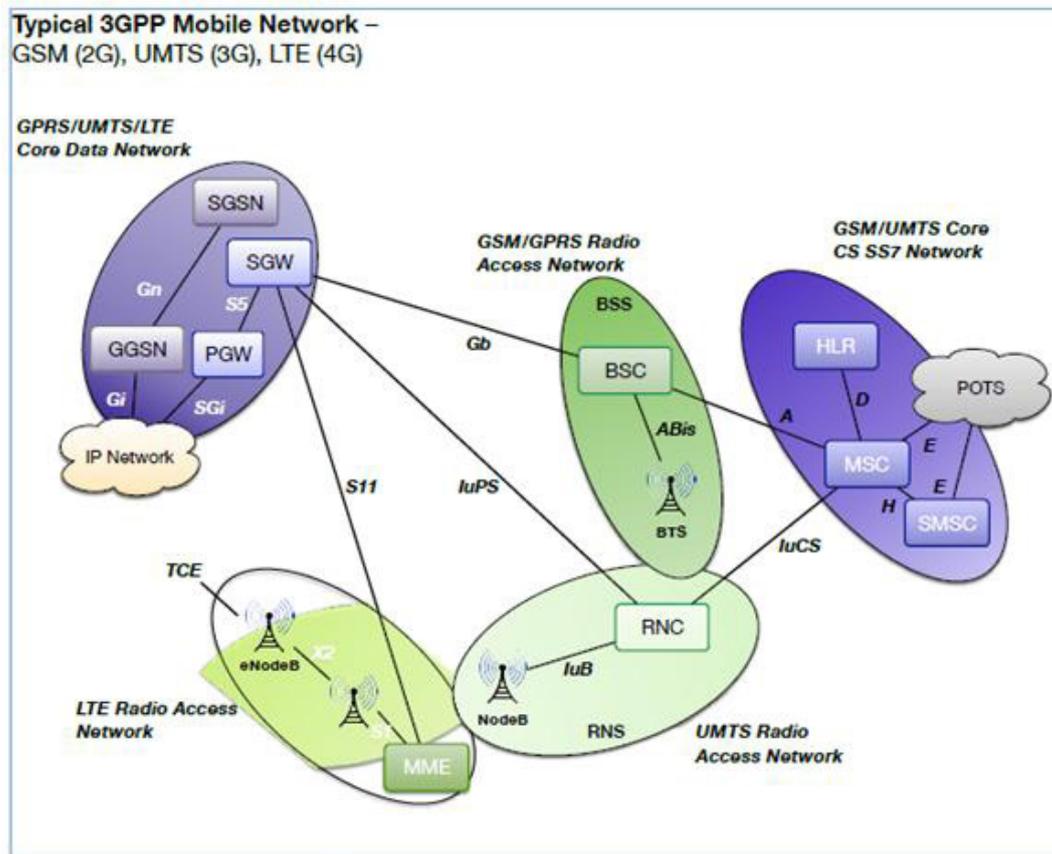
The source data for both types of solutions is quite similar but may be processed or aggregated differently. The most common telecoms data sources in a modern mobile phone network are as follows:

1. CDR Data (Call Detail Records & Billing Records) - data records generated periodically as the subscriber interacts with the network services (voice/2-way video, SMS/MMS messaging and IP data). Historically these were not real time (usually batched into 8 hour windows) and they included basic service information only. More recently, in order to support pre-paid subscribers, they have become more real-time (ideally per-second to prevent/minimize fraud for example) and provide information on subscribers, handsets and location (often to support new billing add-on options). However, these records typically include successful events only (since unsuccessful ones are not billed) and are restricted to service events (as opposed to control information). Despite these limitations many use cases continue to rely on CDR records since they are ubiquitous and easy to integrate with.
2. Core Network Data Records (Core Network DRs) - transaction information gathered directly from the core network elements (either through network element provided interfaces or from passive monitoring solutions). These provide detailed, near real-time information on all the transactions in the network. As service assurance and customer experience management solutions become more widely deployed these data sources are becoming more widespread. Access to the data can be more complex than CDR data and the data is typically presented in vendor specific formats (either data streams or files).
3. Radio Access Network Data Records (RAN DRs) - detailed information about the subscribers' interaction with the radio network. They include data on signal strength, signal quality, interference, handover and location information. Traditionally this was very difficult to collect and therefore was either unavailable or only deployed on a part of the network at a time. LTE and the newer 3G radio elements have started to mandate that this information be available.
4. User-Plane Data Records (UP DRs) - detailed information about the "payload" or contents of a user's transactions. Historically this was only available for services that the telecoms operator was providing end-to-end, for example SMS or MMS, where the payload would have to be examined in order to find and address issues. However, as technology has improved, deep-packet inspection (DPI) means that it is now possible to track all user-plane traffic. This is a potentially very rich data source (especially when combined with the context from the RAN and core DRs). However it is still very expensive and there are data protection concerns regarding how the information may be used.
5. Location Service Records (LSRs) - periodic updates on a subscriber's location (GPS latitude/longitude, azimuth or altitude). This varies significantly from operator to operator, in some cases it may be approximated from core DRs (cell location update messages), from a RAN DR source or possibly from dedicated location tracking hardware. Combined with UP DRs it has the potential to be a very rich data source. Once again, however, there are cost and regulatory challenges in using this data..

For the purposes of this document we will concentrate on (2) Core Network DRs and (4) User Plane DRs since they are the most common/widely deployed and potentially the richest source of data for OSS and BSS applications.

Mobile Network Overview

The following diagram shows the principal network elements in a 3GPP Mobile Network (GSM/UMTS/LTE) covering voice, messaging and data services. The labelled links are typically monitored and individual transactions recorded for both BSS and OSS applications.



Typical 3GPP Mobile Network

These links and the data collected on them would then translate into the following logical services:

Data Source	Logical Service
Map D	Roaming - Subscriber making calls, SMS, using data while abroad Foreign subscriber making calls, using data while in network
A, IuCS	Circuit switched voice and SMS. Subscriber making/receiving calls and SMS on 2G/3G networks
Gb, IuPS, s1MME	Data authentication, data bearer. Subscribers accessing data on 2G/3G/4G networks
Gn-Gi	User-Plane data. Subscriber data traffic presented through deep packet inspection

Source to Logical Service Mapping

Data Sizing

The following tables give an approximate idea of the data sizing (number of records and record sizes) for some sample network sizes (small < 2M subscribers, medium < 20M subscribers, large < 200M subscribers). These numbers are extrapolated and averaged from a number of different networks and obviously rates vary from network to network. Note also that user plane and data transaction volumes are growing very quickly (50%-100% year-on-year by some estimates)

DRs/Day (Millions)	Small (<2M subs)	Medium (<20M subs)	Large (<200M subs)
Voice (CS, VoIP)	15	150	1,500
Messaging (SMS, MMS)	25	250	2,600
Roaming	5	50	500
Data Bearer	50	500	6,400
User Plane Data	900	9,000	9,000
Location Updates	65	650	65,000
Ran Probing	1,600	15,000	150,000
Flow Records	3,890	38,900	389,000
Totals	6,550	64,500	705,000

Sample Data Rates

DRs/Day (Millions)	Record Size (Bytes)	Small (<2M subs)	Medium (<20M subs)	Large (<200M subs)
Voice (CS, VoIP)	512	8 GB	77 GB	768 GB
Messaging (SMS, MMS)	512	13 GB	133 GB	1331 GB
Roaming	256	1 GB	13 GB	128 GB
Data Bearer	256	13 GB	128 GB	1382 GB
User Plane Data	1024	922 GB	9,216 GB	92,160 GB
Location Updates	128	8 GB	83GB	832 GB
Ran Probing	128	192 GB	1,920 GB	19,200 GB
Flow Records	256	996 GB	9,958 GB	99,684 GB
Totals		2.1 TB	21.5 TB	215.4TB

Sample Data Volumes Sample Use Cases of Kx in the Telecoms Industry

3. Sample Use Cases of Kx in the Telecoms Industry

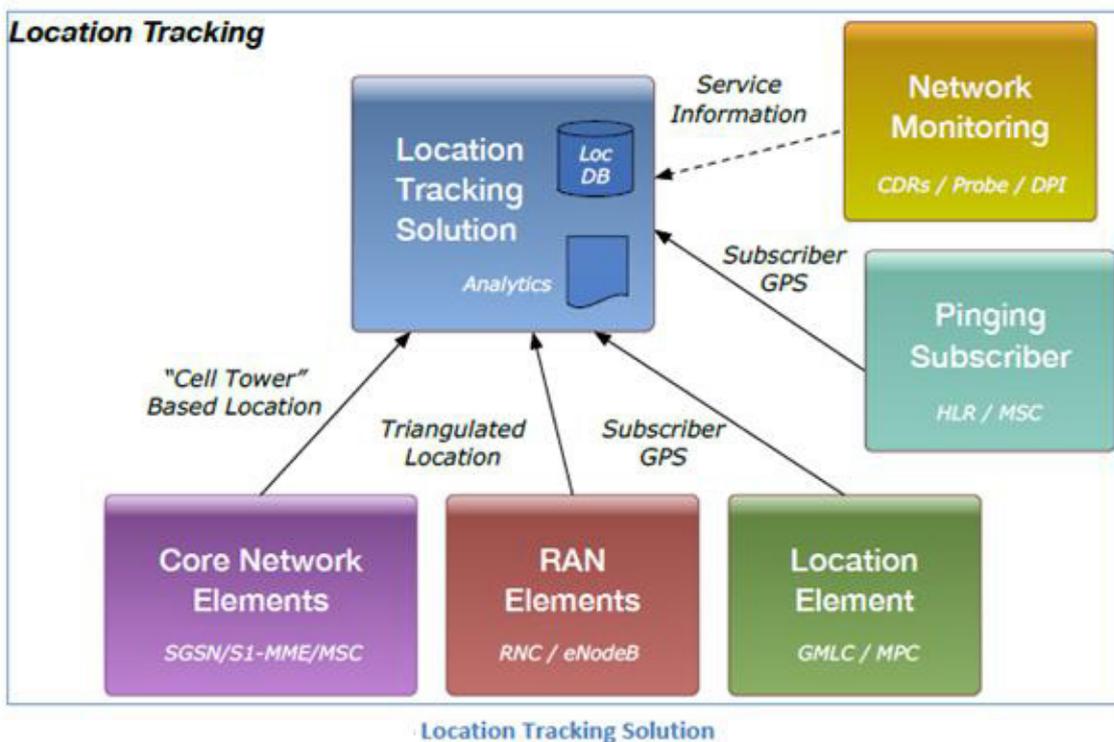
The following use cases illustrate where the strengths of Kx would apply in the telecoms industry:

1. Location Tracking
2. Targeted Marketing
3. Real-time Billing / Content Based Billin-
4. Revenue Stimulation
5. SON / PCRF

1. Location Tracking

The location tracking use case centers on determining the most recent location for subscribers and making this available for a variety of functions (customer care, network performance management, marketing, etc.). There are many different sources of subscriber location available within a mobile network. The most common are:

- Core Network Element Location (e.g. most recent “Cell Tower” that a subscriber has used in a Service request)
- Radio Access Network (RAN) Location (e.g. triangulation of subscribers location from a set of neighbouring cells)
- Active Location Elements (e.g. Gateway Mobile Location Centre (GMLC) or Mobile Positioning Centre (MPC))
- Targeted Location (e.g. pinging a subset of subscribers through HLR/MSC functions)



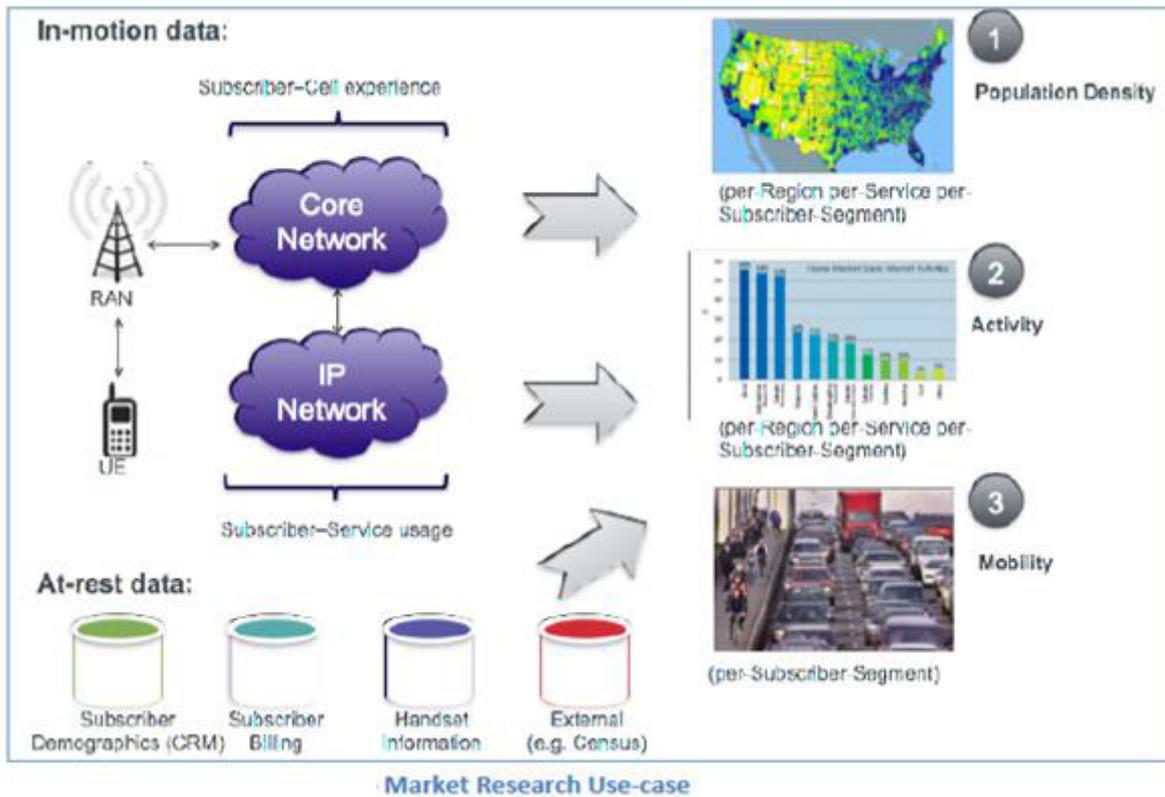
The data challenge arises in collating and reconciling these different sources (each with different location accuracy) while simultaneously providing low-latency access to the processed data and results. A secondary challenge would be correlating this location information with service information (e.g. Facebook vs. Google Maps) to provide segmented location information. Combining historical and real-time location data with analytics would enable path correlation (the ability to segment subscribers by travel type or journey) and location prediction. Also of note is that solutions today are either missing or have been implemented for a small subset of subscribers to satisfy regulatory requirements (lawful intercepts or 911 / emergency calls).

Kx has the ability to collect and persist the data efficiently, which is critical due to the data volumes involved, and make the data available with low latency. In addition it would enable analytics processing and data correlation for segmentation.

2. Targeted Marketing

Most mobile operators are evaluating marketing applications (mobile advertising or market research) as additional revenue streams. However, solutions today are either incomplete (not integrated with the main advertising platforms or delayed uptake feedback) or require significant custom development.

The potential in this case would be to use Kx to extend the location tracking use case to enable targeted marketing campaigns to be managed and run automatically with a level of sophistication approaching the bespoke campaigns today.



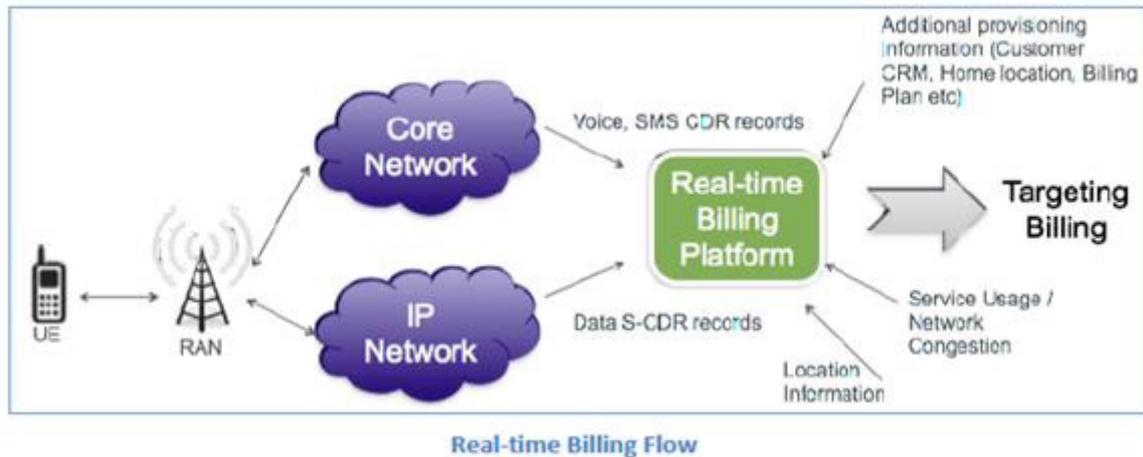
As a specific example, the market research use case is illustrated above. In this case it would combine core network information (population density/movement/traffic) and user-plane (service usage) data with at-rest provisioned and derived data (subscriber demographics and billing, handset information and external marketing information e.g. census/household median income, etc.) to provide extensive market research information:

- Subscriber Count (for a given user segment) in a specific area by time.
- Activity (for a given user segment and service) in a specific area by time.
- Mobility (for a given user segment) along a specific route by time.

Once again a crucial advantage of Kx in developing such a solution would be its ability to collect and persist the data efficiently along with its real-time processing at high volumes.

3. Real-time Billing / Content Billing

Billing within the mobile telecoms domain has traditionally been a batch-driven process. Moves towards a real time billing function (e.g. customized applications for mobile networks enhanced logic) have been introduced to support pre-paid roaming and to minimize fraud. However, even these solutions remain quite basic. There is a strong drive for a more general, real time billing function to support new service offerings and revenue models. The potential in this case would be to develop a real-time billing solution that would either lower the latency (revenue leakage/fraud) or cost (server efficiency) of the existing legacy solutions. In addition, it would allow for new billing models such as content billing.



An example real-time billing flow is shown above. Key advantages over traditional billing would be:

- (a) An improved platform (lower cost, less revenue leakage)
- (b) Ability for custom “targeted” billing using additional information (location, service usage, network congestion, etc.)

The low-latency and high-performance aspects of Kx would be a strong advantage in this area and the accompaniment of its programming language q, with its ability to handle data in flight offers significant benefits over traditional SQL approach

4. Revenue Stimulation

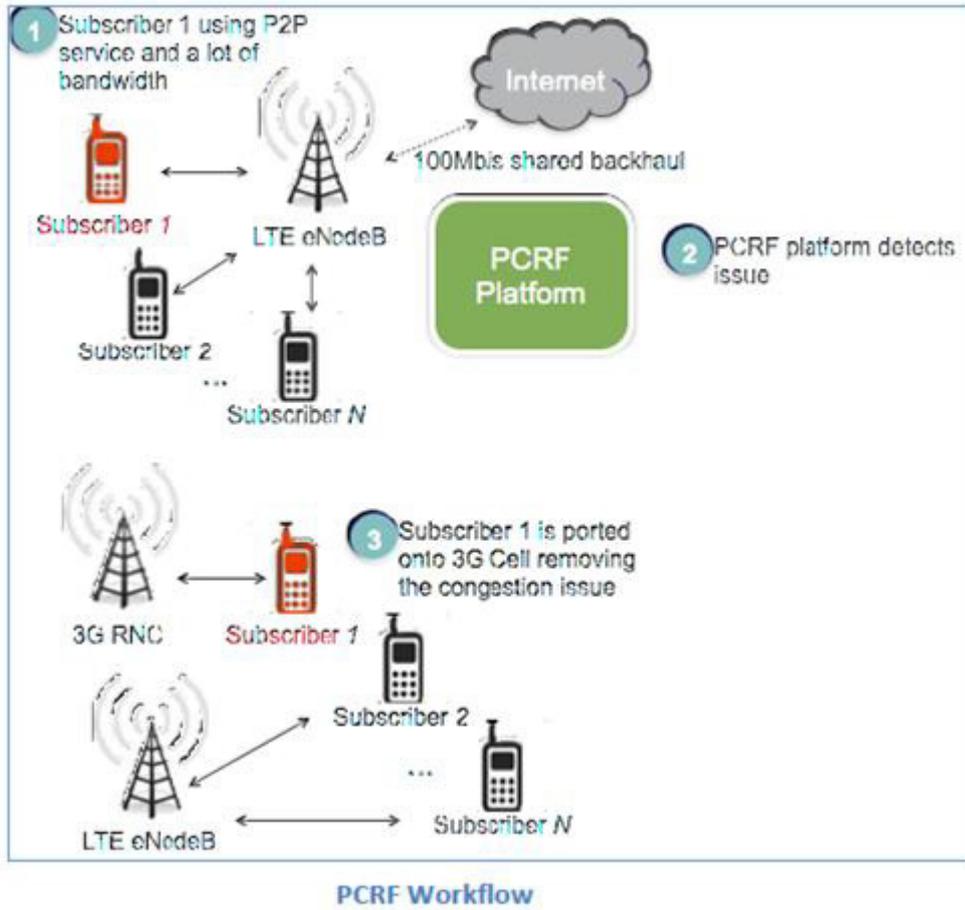
Related to the real-time billing use case above is the concept of allowing dynamic service pricing (on- demand pricing) to stimulate service usage or better balance network resources.

The basic concept is that at periods of off-peak utilization, subscribers could be offered lower cost service use (i.e. lower data rates or reduced cost call minutes). However, legacy billing solutions and non real time pricing make this difficult to implement. A Kx-based solution as an extension to the billing use case would provide the required capability.

5. SON / PCRF Automation

Self-Optimized Networks (SON) is a drive within mobile operators to improve quality and reduce cost of both engineering resources and network equipment by automating many of the network management and optimization functions that are performed manually today or on an ad hoc basis. PCRF (Policy and Charging Rules Function) is a related concept where subscribers could be charged dynamically based on resources used (quality, network throughput or network latency) or more commonly apply traffic shaping and network limits to balance the use of network resources more evenly across a number of subscribers.

Some of the SON and many of the PCRF proposals require near real-time data processing, for example a user “hogging” the network bandwidth with a bit torrent download could be handed over from an LTE to a 3G cell. This would require millisecond latency data collection and rules processing which limits many of the solutions today.



The complexity in this case is the very high degree of integration (performance data, configuration data and rolling out changes) required to implement either SON or PCRF automation and also the need to allow auditing and rollbacks to mitigate risk. Once again the openness of Kx, speed of processing and its development environment would support the required performance, integration and development demands.

4. Telecoms Case Study: Bandwidth



I

Bandwidth Selects Streams for Kx for Real-time Business Intelligence and Network Quality Alerts

Kx, a leader in high-performance database and time-series analytics, announces that its Streams for Kx for product will be used by Bandwidth, one of the fastest growing and most innovative communications technology providers in the US, to fulfill its real-time systems monitoring requirements. In particular, Streams for Kx for will be integral to Bandwidth's Republic Wireless product, which provides consumers access to a cost-effective smartphone solution that uses Hybrid Calling technology to leverage both cellular and Wi-Fi networks for data, talk and text.

Bandwidth needed a solution that would provide views on system statistics, as well as the ability to implement alerts to detect anomalies that may indicate the need to reallocate server resources or investigate unusual usage of the Bandwidth network. This ability to monitor their resources in real time gives Bandwidth's Republic Wireless team key insights on the efficiencies of their network and allows for better capacity planning as their business grows.

As the volume on the network increases, the number of data points being generated has risen dramatically. Streams for Kx was deployed to capture the pertinent system quality and latency statistics and store the processed information to disk for historical benchmarking.

Republic Wireless staff also benefited from kdb+ training and accreditation, allowing the analysts to develop ad hoc analytics and alerts in house, which are then distributed to the Republic Wireless staff members through the Kx Dashboard visual layer.

Streams for Kx is in use globally at securities companies, trading exchanges and telecom companies to meet a range of business challenges. It is one of the world-class, flagship applications within the Kx suite, a powerful "Big Data" platform, offering capabilities in data analytics, event processing, algorithmic trading, FX aggregation and risk management.

Jim Mulcahy, EVP & General Manager for Republic Wireless, said of the new system: "Streams for Kx from FD offered us the ideal platform for processing the high volume of systems data that passes through our networks. As a result we now have real-time insight into the efficiencies and demands on our network that in turn enables us to better manage our services and continually improve the overall customer experience."

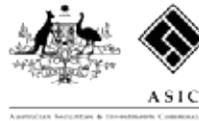
Brian Conlon, Kx's CEO, said of the selection of Streams for Kx by Bandwidth: "We are delighted to partner with a progressive technology company like Bandwidth. Although Streams for Kx is used primarily and extensively in the Capital Markets, the flexibility of the technology means that it has applications in other sectors such as gaming, energy, utilities and telecoms. The adoption Streams for Kx by Bandwidth attests to that adaptability and openness."

About Kx

Kx is a division of First Derivatives PLC. It was founded in 1993 with a goal to address the inability of traditional relational database technology to keep up with escalating volumes of data. This problem is even more acute today, where data records can number in the trillions — and yet businesses nonetheless need immediate access to both real-time and historical data for trading, research, smart meter data analysis and other applications.

Since the company’s inception, Kx’s primary goal has been to provide its customers with the fastest, most efficient and most flexible tools for processing real-time and historical data. This focus has enabled it to become the worldwide leader in high-volume, high-performance database operations.

Download a free trial version of Kx at www.kx.com





EMEA

Head Office

3 Canal Quay
Newry
Co. Down
N.Ireland
BT35 6BP
Tel: +44 (0)28 3025 2242

Belfast

11-13 Gloucester Street,
Belfast,
Co. Antrim
BT1 4LS
Tel:+44 (0)28 9023 3518

Dublin

Fleming Court,
Flemings Place, Mespil Road,
Dublin 4
D04 N4X9
Ireland
Tel: +353 (0)1 630 7700

London

Cannon Green Building
1 Suffolk Lane
London
EC4R 0AY
Tel:+44 (0)207 3371210

Zurich

TBC

Americas

New York

45 Broadway,
20th Floor,
New York,
NY 10006,
USA
Tel:+1 (212) 447-6700

Toronto

36 King Street East,
4th Floor,
Toronto, ON
M5C 1E5,
Canada
Tel: +1 (647) 256-6626
Tel: +1 (647) 256-6625

Ottawa

300 Terry Fox Drive
Unit 600A
Kanata, Ontario
Canada K2K 0E3
Tel: + 1 (613) 216-9095

Palo Alto

555 Bryant Street
#375 Palo Alto
CA 94301
Tel: +1 650 798 5155

APAC

Singapore

Unit 12-01,
55 Market Street,
Singapore,
048941
Tel:+65 6592 1960v

Sydney

Suite 201,
22 Pitt Street,
Sydney,
NSW 2000
Australia
Tel: +61 2 9236 5700

Hong Kong

Two Exchange Square,
8 Connaught Place,
Central,
Hong Kong
Tel:+852 2168 0715

Tokyo

Sanno Park Tower 3F,
2-11-1 Nagata-cho,
Chiyoda-ku,
Tokyo, 100-6162,
Japan
Tel:+81(0) 36205 3494

