# Architectural Considerations for Performance Management Systems

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Readers to note: This draft version is very long! I apologize in advance for the length (and please consider this point as a being noted) but tried to make as complete as possible. This document is an attempt to collate the answers to the many questions asked in the past which cover the problems and architectural considerations as seen in various systems. Answering these issues will help the reader understand how the systems work, and possibly their limitations. I will be trying to complete this in the future (but already asked to distribute to several personnel and in some cases discuss various sections in detail) but accepted that it will never be finished.

This is also essentially a set of notes and logical thought process for a presentation (intended for TMForum Technology Interface Program (TIP) study that will begin in 2009).



## 1 Synopsis

Issues seen in the deployment of a Performance Management (PM) systems within Operators are felt to be extremely important to document. This is especially when the issues were found to be in the fundamental architecture of the Performance Management Products available and the lack of industry standards for the generation of performance statistics files. These fundamental issues once explained can form the basis of specifications when ordering such systems as well as managing the expectations of the capabilities of a delivery. The paper concludes with a recommendation for the standardization of several features within the performance statistics files to reduce the systems integration costs.

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# 4 Introduction

## 4.1 What are the Performance Management Systems covered in this document?

Performance management systems used within the Telecoms area fundamentally:

- Collect performance data from the Network
- Manipulate (Parsers) the data so that it is in a suitable format for loading into the database
- Load the data into the database
- Summarize the data from the hourly data to daily (with a variety of important data retained such as the values at Busy hour, Daily Total etc), weekly, monthly.
- Off line / Archive – Essentially remove data from the database to ensure the database does not become excessive in size
- Extract the data when requested
- Present the data as information.

Note that: Extraction from the database and presentation has been listed separately for reasons that will become apparent later in this paper.

The performance data collected and discussed in this case is not the Call Data Record's (CDR's) but the files which the equipment produce that tell the analyst what the equipment is doing / how heavily it is utilized which is then used for analysis of the equipment performance (and subsequently the network). CDR's that most telecom personnel would be familiar with from billing applications. The CDR's contain a detail of when each call

started, how it was routed through the network(s) and when the call was terminated (amongst other things). One use of this information is to combine it with a rate plan to provide the billing information to the end customer.

The purpose of this paper is not to discuss the benefits of CDR data vs. Equipment produced (performance data). Generally they can be considered as complimentary as performance files are the equipments perception of the network (and the manufacturers would not produce performance files if not relevant). Occasionally the CDR's are collected aggregated by the Performance Management vendors (e.g. 200 calls to Spain in a given hour) and loaded into the Performance Database as if they were counters. This particular variation on recording performance however this is not discussed here.

Equipment that produces performance files includes most Radio Access Equipment (Base Station Subsystem (BSS)) , Switching equipment (NSS), Packet Core (SGSN), Gateway GPRS Service Node (GGSN), Fire Wall (FW), Voice Messaging (VM), Short Message Service (SMS), Asynchronous Transfer Mode (ATM) equipment ……. On occasions when equipment does not produce performance data, methods for SNMP polling to determine the instantaneous performance of the equipment exist (which may poll say every 5 minutes) to produce a form of performance statistics and overview.

## 4.2 Why have performance Management systems?

Performance Management systems are used to monitor the network for both short and long term reasons. The system is usually designed as a data warehouse such that both the short and long term aims are both accommodated.

### 4.2.1 Short Term aims

Identify poor performance of the network elements (such as "Dropped Calls" greater than 2%). Trends of the element performance over the last week (or sometimes months) may show the sudden or progressive degradation which may result in an office based activity such as Frequency change or alternatively a site visit to adjust an antenna or replace a part. The trends may also indicate a progressive loading of the element (such as a cell or trunk route), such that action (such as an additional Transmitter Receiver (TRX) on the cell or additional time slots added within the transmission link) can be taken before the element is overloaded and service impacted.

### 4.2.2 Long Term aims

The longer term performance monitoring may be used by different personnel and for slightly different reasons. Network Architects will be looking at the results to assist with the longer term capacity planning and budgeting. Figures provided by market forecasts and industry trends many then be combined with the technical measures from the Performance Systems such as customer growth (monitored though the Switch databases), traffic trends (monitored through both the core switching and radio), which may provide and estimate of Network expansion requirements (e.g. 10% increase required in transmission, 7% increase in TRX and 3% increase in cells).

In a multi vendor environment the number of calls dropped by one vendor compared with the second may be factored into decisions as to which vendors' equipment should be purchased where there is a choice.

Internal benchmarking of the network quality is also considered. Over the last 5 years the network has improved progressively from a 1.7% dropped call to 1.3% overall. Regionally the figures may indicate one region performs better than another (and this may be due to different number of staff to equipment ratios, different tools and work practices or simply geographic conditions (impacting quality of radio transmission).

## 4.3 Main Components

We will discuss in this section the main components of a performance management system as described in the introductory section "4.1". A diagrammatic representation is shown below in "Figure 1 Performance Management System Components".

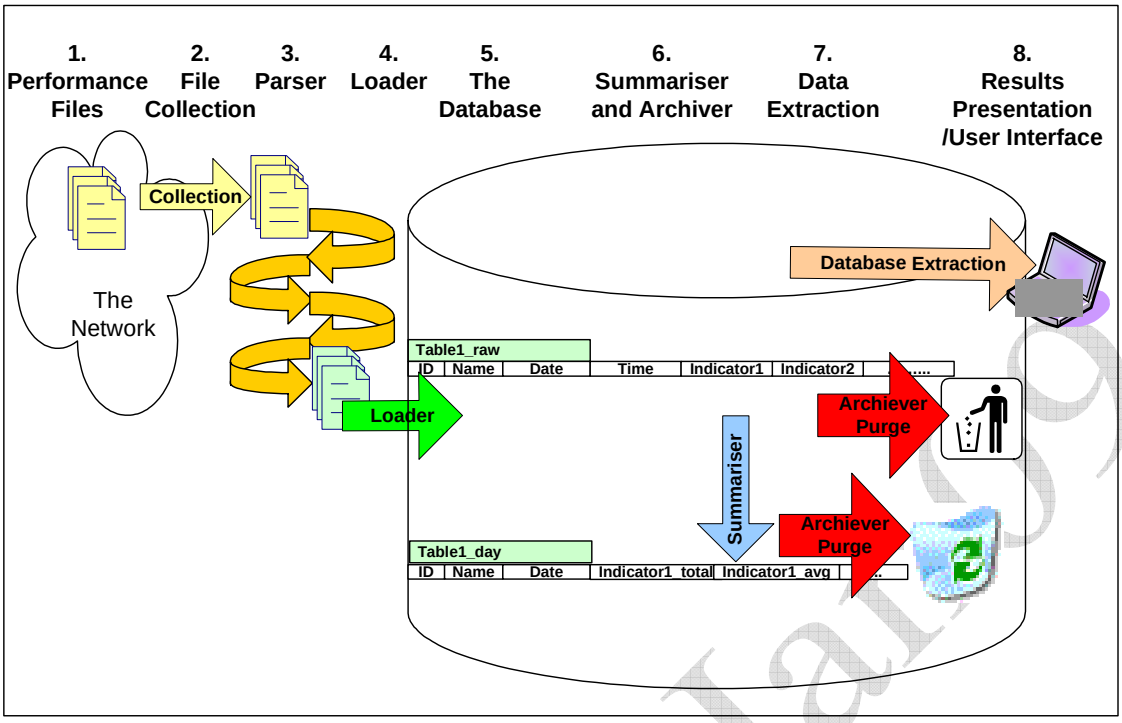


***Figure 1 Performance Management System Components***

### 4.3.1 The Performance files

Equipment manufacturers output these performance files in a variety of formats (ASCII, XML, Binary ….) and the catalogs on how to extract the data can be quite large and several volumes. As the equipment manufacturers are responsible for the design and manufacture to achieve the functionality of their equipment the counters can vary enormously. Some standard indicators do exist such as “dropped calls” for the Radio Network (when the call is dropped without one of the participants hanging up). These indicators (such as dropped calls) may be due to a number of reasons within the equipment and in such cases will be a mathematical aggregation of different causes and therefore different counters for different manufacturers. In general the number of counters produced by a piece of equipment is in their 100’s or even 1000’s. The numbers can be so significant that the system can be configurable to permit the collection of only the counters of interest to the analyst or place limitations on the number of network objects that a counter can be activated on (e.g. can only activate 10 cells per Base Station Controller).

The period of the data interval is often configurable and it is up to the operator to select if the interval should be 5, 10, 15 …minutes or an hour.

### 4.3.2 Performance file collection

These are relatively simple scripts that extract the data off the supply source or sometimes disk mounts. While the source is normally a Unix server/OMC (used to manage the network equipment) it can be direct from the element and documentation from the equipment manufacturer is essential and normally available to design the extraction method. Data communications to the equipment and passwords/rights to access the files are required.

### 4.3.3 The Parser

One of the consequences of the lack of standardization is that for each equipment interface for which the Telecom operator wishes to collect data, a parser is required to manipulate the performance files into a format that will allow the loading into the purpose built database (structure).

Following the data collection these parsers traditionally combine the Hierarchy files (again supplied by the equipment) with the actual performance files (containing the period statistics such as the number of dropped calls), and if required aggregating the time intervals to a larger interval (such as 15 minute files into a full hour) to make the loader files suitable for loading into the database.

### 4.3.4 The Loader

The Loader effectively loads the files created by the parser into the predefined database.

### 4.3.5 The Database

The software vendors use a variety of Databases which can be proprietary (i.e. their own development) or based upon a commercial database such as Oracle, Informix, Sybase etc. The databases may be customized or special functionality built into them. This functionality is to allow them to provide the statistical functionality required for the telecoms sector. This may be to allow the calculation of what is the Busy Hour (which may or may not be a statistical Mean) which is added into the database functions / procedures / features.

### 4.3.6 Summarization and data removal

It is important to note that if we kept all the data collected from a large network forever the amount of storage space (disks), COU, memory requirements would increase dramatically (requiring Massive Parrallel Processing techniques) and the system response impacted.

The summarization and data removal procedures that summarize the period (often hourly) data into daily, weekly, monthly tables as well as the procedures that remove old data (archive or destroy) are essential to the system performance.

### 4.3.7 Extraction from the Database(s)

The data extraction from the database varies from one software supplier to another. The one thing they have in common is that they all use some form of Structured Query Language (SQL).

Some of the factors that impact the extraction are how many tables are being queried and the efficiency of the query or queries. It is relatively easy to build an extraction method to query 2 or 3 indicators from a single table on a small network. Unfortunately for most operators this is far from the case.

In some cases operators wish to know what the Packet core is doing at the same time as the Radio network (the Packet core and Radio suppliers both may have sections of data which relate to cell level). The larger the network the greater the amount of data generated per day and hence impacts the table sizes. This shall be considered later however to introduce the issues and its impact on the system we can consider that a CELL may be configured to allow handovers to 15 neighboring cells. The implications are:

| | |
|---|---|
| Assuming each hour is stored in a single row | i.e. 1 row |
| Each row has a source cell and neighbor cell | x 15 entries |
| Size of network is 10 000 cells | x 10 000 |
| Number of hours per day | x 24 |
| Total number of rows added per day | = 3 600 000 / day |
| Data retention policy of 1 month (31 days) | x 31 (days) |
| Total number of rows in table | = **111 600 000** |

For this reason some vendors have historically had each day of hourly / raw data stored in an array to reduce the number of rows stored (by a factor of 24 in the above example). If an operators has a 30 000 cells network they may be forced to analyze the performance data in a different way and not bother with handover details to each neighboring cell separately but the drops from one cell to all neighbors aggregated (to reduce the number of rows by a factor of 15 in the above example).

### 4.3.8 Results Presentation

The results of the queries may be presented via the Performance Management System of the manufacturers own display system using some form of x-terminal but normally make extensive use of other technologies such as an Web servers and Java to provide a Windows look and feel. This can create issues in themselves, as the management of these applications needs to be considered and are rarely so reliable they can be forgotten about.

In addition, the automated publication of reports in Adobe format for management reporting, *.csv for the engineers to push into further applications are common. More and more the integration of direct SQL by external applications such as GIS (Geographic Information Systems) is a mandatory requirement. This presents its own issues which will be discussed later.

### 4.3.9 Administration

These are the tools supplied to help administer the system from the identification of which files are available to collect through the processing, summarization, archiving, user administration, server monitoring and report production monitoring.

## 4.4 eTOM (enhanced Telecom Operations Map)

If we look at where the Performance Management Systems fit into the eTOM model we can see the areas highlighted (white background with green lettering and border) are all associated with the “Assurance Area”. Some people may argue that good assurance is a key selling point (and therefore should include other areas), so while debates may continue “Figure 2 eTOM highlighted for Performance Management Systems” below serves as a guide.

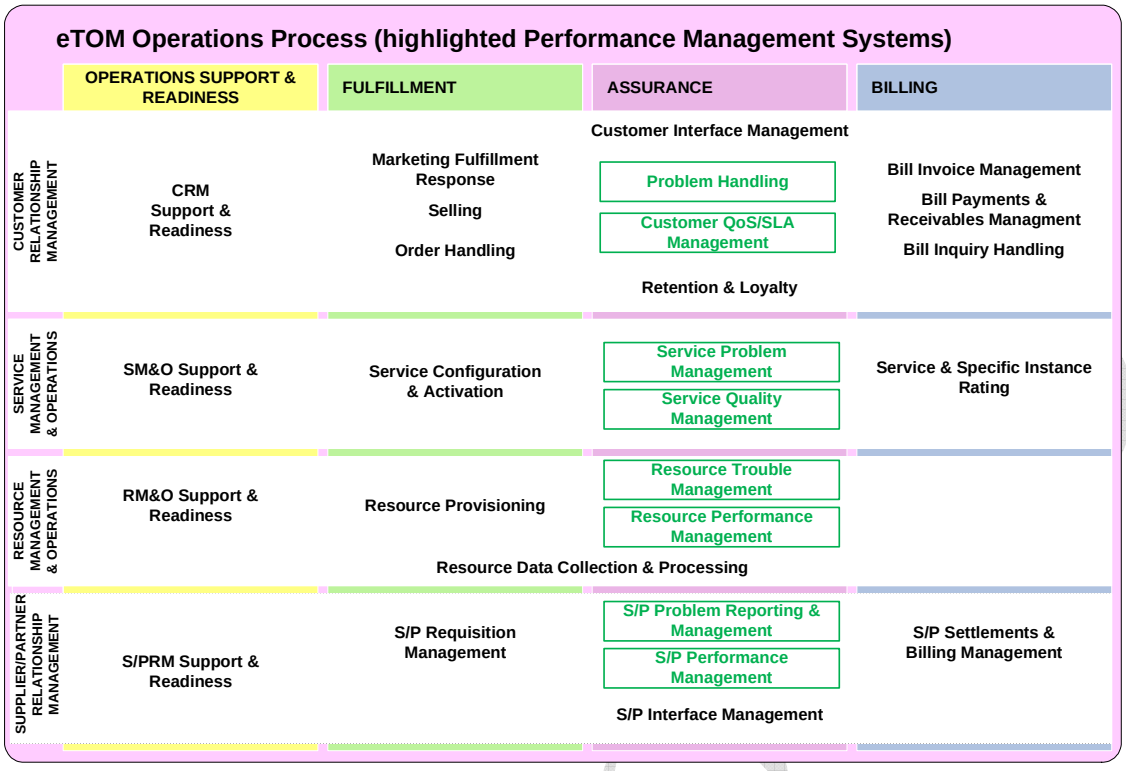


***Figure 2 eTOM highlighted for Performance Management Systems***

## 4.5 TAM (Telecoms Applications Map)

If we look at the TAM we can highlight the areas (white background with green lettering and border) we can see that any organization that delivers a "SERVICE" must monitor the quality of their network. While 30 years ago the passing of a folder from one department to another and after several months someone accepting the problem and rectifying it, such practices are no longer relevant and a more proactive integrated system is required.

As with the eTOM there will always be some debate as the Performance Management System fit into the TAM outputs from the Performance Management Systems may be used in other areas. One example is that the Total Traffic on Interconnects may be measured by the equipment (through the Performance Management System) and then correlated with total of Billing data (as a sanity check to verify all Route traffic was actually billed to customers). On a similar basis, the sudden changes in traffic may alert those monitoring Fraud (e.g. a cloned SIM card placed in a call generator and connected to the Operators Network).

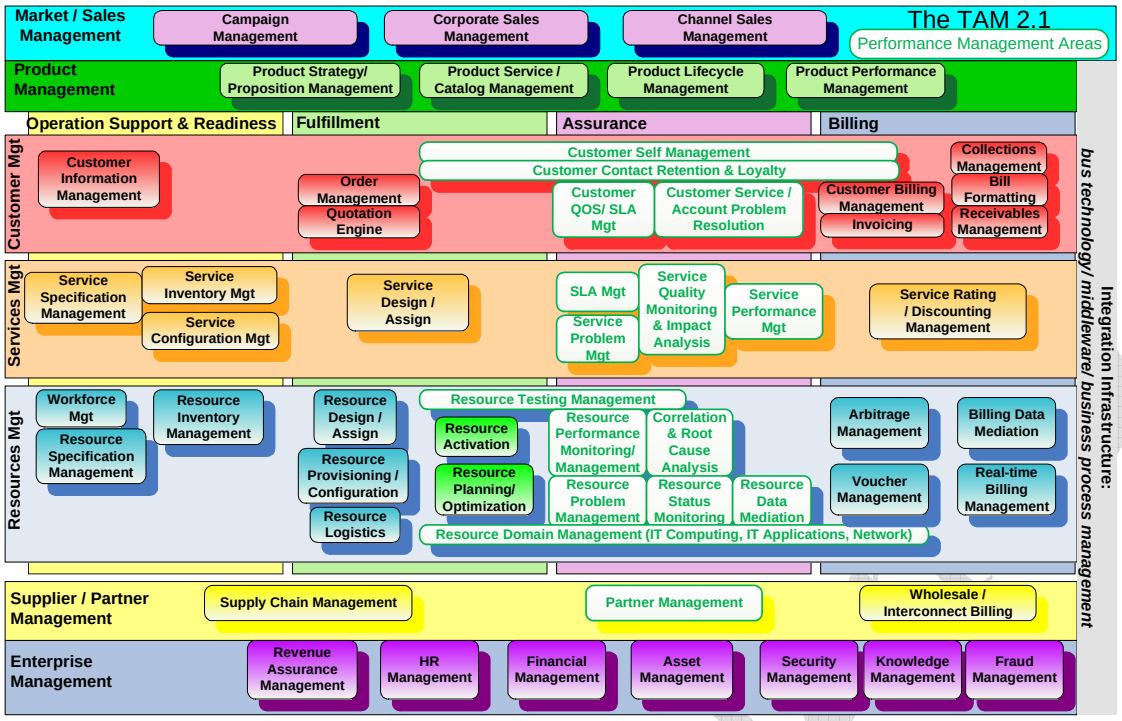


***Figure 3 TAM Highlighted for Performance Management Systems***

If we look at the many areas of the TAM we can work out which areas of the TAM may be impacted (areas shown in green lettering and border with white background):

### 4.5.1 Customer Management

This area is usually associated with add on applications such as showing the Network Performance on a Map to customer services staff along with Trouble Ticketing information. This can assist call center staff and in some cases may be made available to the Managers of a Virtual Network Operator (which may be regarded as one large customer).

### 4.5.2 Service Management and the Assurance

The typical Performance Management systems cover all these 4 areas:

- SLA Management – Radio or Trunk Route uptime impacts the end users Service Quality (such as the number of dropped calls which is a Key Performance Indicator of the performance of a Radio Network).
- Service Problem Management – The identification of the drop off in performance is followed by some detailed analysis, action and then monitoring to see the service has resumed to acceptable levels of service.
- Service Quality Monitoring & Impact analysis – Outages or performance reductions per cell are sometimes compared with the

loss in revenue (based upon normal expected load and average revenue per call).

- Service Performance Management – Based upon the impact, resources (technical experts) may investigate the issues remotely or on site for more detailed measurements and action. The service performance from a short term (tactical purpose) along with the longer term (capacity forecasting) are facilitated.

### 4.5.3 Resources Management

Typically the Network design is derived firstly from a guess of the likely traffic and this is followed by measurement using the PM systems and appropriate action taken. Hopefully for the operator this means the expansion of the Network with a growth of traffic. This is one of the major areas where the performance management systems are traditionally used.

- Resource testing – The impact of changes on the network, (determined from before and after measurements) are standard practice and hopefully the results show that a rollback of the Netork Resource) change is not required.
- Resource Performance Monitoring – Thresholds for performance (say 1% or 2% dropped calls may be the policy of a mobile operator and this performance is closely monitored and alarms set up to monitor the network performance.
- Correlation of Root Cause – In the case of many cells failing the interfacing of the Performance Management system with a GIS application can quickly identify the element in the Network hierarchy that may be the problem such as a Transmission Hub Site (THS), Base Station Controller (BSC), Mobile Switch Center (MSC) or somewhat more difficult to determine may be a Routing Area Code (RAC).
- Resource Problem Management – Actions are frequently taken by Radio Optimization professionals when problems in performance are identified and while a ticketing system in the main Management Tracking tool the before and after Performance Analysis from the reconfiguration or repair is a key ingredient.
- Resource Status Management – is normally by the alarm module of the Performance Management system. In some cases a cell may get “stuck” for a certain feature without sending an alarm to the Operations and Maintenance Center (OMC). Alarms may be raised based upon a combination of counters. If Call Attempts=100 while

Call Successes-0 the Resource may be effectively off line and is easily detected by the Performance Management system.

- Resource data mediation – ??? check precise TMForum definition ???
- Resource Domain - ??? check precise TMForum definition??? if we consider a domain being a BSS vendor then the monitoring of that domain and comparing with another vendor may indicate inherent quality differences that may be used for evaluating the vendors comparative value to the operator

#### 4.5.4 Partner Management

- If a vendor was considered a partner then would be similar to the Resource domain.

# 5 Common assumptions

There are many common assumptions made in the design and construction of these types of applications which can create significant issues which can "Crash" the system or make it far less useful and reliable than it should/could be. We will state some of these assumptions and in the follow up discussion outline, some of the problems that they can cause.

## 5.1 We are building this and will be great

The major issue with such system lies in the first consideration discussed in section "4.3.1 The Performance files". Manufacturers with new software releases invariably add additional counters and often change their output standard (from ASCII to XML for example). This means the maintenance of parsers, upgrades of database structure and the loaders become an ongoing issue.

Once a performance and reporting system is made reliable then the operator does rely on it! As such, reports are made available for the Executive Board and if a system is down for due to reasons outside the application such as application / network upgrades then "heaven help the performance manager administrator".

## 5.2 The data supply is regular and reliable

The flow of data from the equipment can be shown in the diagram "Figure 4 Performance Management Data Flow Diagram" below.

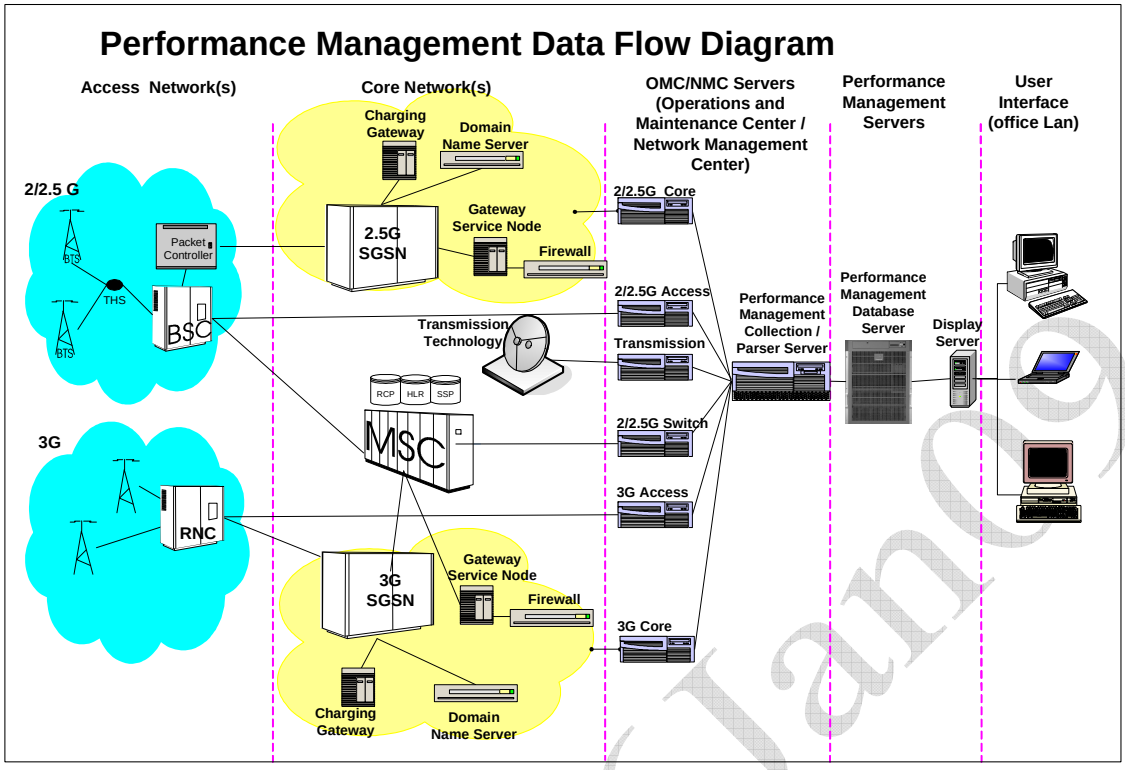


***Figure 4 Performance Management Data Flow Diagram***

The actual equipment types and numbers can vary enormously as can the hardware architecture of the Performance Management systems themselves ("Figure 4", shows a Collection, Database and display server which may be combined as discussed in section "6 Which Hardware Architecture is right?"). In many cases the system supplied within the equipment OMC has a database suitable for the purpose and transfer of data to a dedicated Performance Management system is not justified. There may also be numerous Transmission types, more than one Radio Supplier and many more interfaces so the diagram is very simplistic.

Data supply is often delayed due to:

- OMC Upgrades may represent a significant outage in the data collection (8 hours downtime overnight and then another 6+ hours to recover the data from the network) before collection can resume.
- Data communications outages (on supervision side and not necessarily the customer side). This can result in data loss, late delivery or supplementary file delivery. E.g. For an RNC (per Architecture shown in "Figure 4 Performance Management Data Flow Diagram" above may have the:
  - 1st file hold 90% of data,
  - 2nd file an hour or more later 5% of data and the

    - 3rd file possibly 12 hours later with the remainder of the Cell data

  associated with that RNC by the OMC and made available to the Performance Management System.

- Equipment reboots - some vendors recommend their OMC is booted on a regular basis.
- Equipment resets - if there is a loss of production of an element for 1 minute then no data file is produced for that time period (which may be configured as one hour). This can conceal faults unless the performance system is reliable and the amount of missing data can be traced to (in one vendor 90% of missing GPRS data found to be due to the GPRS Packet Card resets).
- Equipment overload – Data collection and forwarding by the Telecom equipment is one of the lowest priorities within the equipment (as it should be as the customer / billable traffic should and does take priority).
- Equipment underload – Some manufacturers assume that the amount of data may be so small that the transfer to the OMC should wait until the following period and as such one file containing 2 time periods of data are sent (and along with the delay the parser needs to detect and manage).

There are many more causes of data delays and loss and the reasons and behavior can vary from one manufacturer to another.

If one considers a:

- network with 10,000 cells,
- being collected through an extensive transmission network to
- say 20-100 BSC/RNC (depending upon the supplier and network architecture and note that this number is constantly changing)
- again being carried by a transmission network to
- one or several OMC's
- which is then extracted and transmitted towards the performance system

then the number of potential failure points it significant and it is little wonder there are often issues. It becomes even more difficult when equipment suppliers decide that they will not produce a file if there is no activity on that part of their equipment (e.g. a cell). Therefore if there is no data, is the cell

down or not being used or something wrong with the data communications preventing the file from arriving or …).

## 5.3 They are simple file formats to process

While these systems can be described in very simple terms (as in section "4 Introduction") the complexity will become apparent both within this section and throughout this paper.

The documentation is usually delivered to the operator with the upgrade in the form of several Adobe PDF files (which offer the vendor the surety that the information cannot be altered). The PDF files may be split up in such a way that they contain the:

- Counter name and short description in one volume (sometimes over 1000 pages),
- Counter format (e.g. Accumulation, Numeric format e.g. 8 character) along with other special details such as the counter must be divided by 10 (as it should be a single point decimal but the equipment Network equipment cannot generated such a format)
- File format and groupings (how the performance file is formatted and ordered so the parser can be built). Often the topology files are separated so that they need to be joined together such that the CELLID and CELLName can be loaded together with the performance data into the database.
- The documentation may then be split up for each section of the equipment. An example split up for the Radio Network may be:
    - Cells and BSC equipment
    - Packet Processing Equipment - To make matters more complex some of the counters generated by the packet equipment may actually be related the Cell and BSC equipment (related to the inter-working). In the case of loading into the data base designed for a given element (in this example the packet core element) the user then may want these loaded in the same table as the features they related to (coming from the CELL or BSC equipment).
- Lastly another volume may exist on recommended complex indicators (which counters should be added together to calculate the total dropped calls of a cell). The recommended complex indicators may be in the hundreds.

The quality and format of the documentation along with the availability of sample data has a direct impact on the ability to quickly and accurately develop and deploy the performance management systems. This becomes more critical when considering upgrades where the Network upgrade is performed overnight and it is expected the performance system will be working the following day to assess the impact of the upgrade.

### 5.4 The Impact of the common assumptions

The common assumptions lead to a number of issues which will be discussed in more detail later. One thing that can be stated at this point is that when a system

- Does exist and the potential to help the Network Managers is recognized or
- When the organization develops a reporting dependency on such a system (that the executive team is reliant upon)

and it does fail to produce the reports, the ability to answer questions proactively through a good monitoring system (e.g. it was the failure in the network of xxx) immediately is very important or "heaven help the performance manager administrator" and the reputation of the Performance Management vendor.

## 6 Which Hardware Architecture is right?

Suppliers may suggest a variety of different hardware architectures. It can be somewhat confusing as to why an architecture is being suggested! We will go over the major PM Functionality and discuss the different considerations that the purchaser may be presented. Some of the things to consider include:

### 6.1 Collection hardware

Outages and downtime can have an influence on the proposed architecture. If the system is Unix based and patching is required (say every 6 months) then an outage is likely to be for several hours. In some cases when the Network Equipment does not hold a buffer of some duration, you may wish to collect all the data from 2 small servers (in a duty and standby mode). These may only cost a few thousand € to purchase and install. The equipment suppliers now days normally have the buffering capabilities (normally measured in days but some older equipment had none) and in most cases missing is few hours of data is not normally considered critical.

## 6.2 Parser hardware

Should you have a separate parser server so that the main server is reserved for the data base work (loading and extraction)? This is often promoted and can be desirable. The parsers can take significant server load when operating, and in a data catch up situation (as discussed in the assumptions section “5.2 The data supply is regular and reliable”), a parser server can absorb the some of the processing load (rather that all being taken by the main server) leaving capacity for the database server for the loaders and end users requested SQL’s.

One significant negative of the separate server however is the transfer of data from the parser server to the database server (for the loading). If the files are transferred before loading then this is another overhead on the cluster of servers that are being considered. Should the data be parsed into a special file system mounted by both the parser and database server then an overhead is created in the 2 servers negotiating to access to the same disks (i.e. the two operating systems need to co-ordinate to determine):

- when the file has finished being created
- confirming it has indeed finished and is available for
- the second server to pick up move to another directory and load into the database).

The size of this overhead can be significant. Fortunately in recent years the operating system have improved and software has become available to handle this specific task (the author has not had sufficient recent hands on experience to see the improvements).

## 6.3 Display hardware

Some suppliers will keep the hardware for generating the SQL and displaying the data on a separate machine from the database server. This allows the database server to do the one task and hopefully do it well. The display software could be web based and requiring products to manage the web interface. The web user interface can create an overhead and configuration issues may create significant undesirable load and hence often considered best on a separate server.

The SQL can be generated on the display hardware (most likely has an ODBC driver to issue the query) to execute on the database server and then post process the results into a format that is desired. One thing that needs to be ensured is that the display hardware is capable of handling the amount of data that will be passing through it.

Should the results of the SQL be buffered within the database or onto the database server and then transferred to the Display server the data communications becomes absolutely critical.

In terms of which way the industry is heading this remains open. The storage of the reports and some data collection is seen by some Performance Management suppliers as the key feature and needs to be stored on their server to allow quick automated refreshing etc within the application as well as easy drill down from the alarms to a report. Others are happy to put this task out to the 3rd party that specializes in this area.

A critical issue for organizations that get heavily involved in the Performance Management area is the additional interfaces such as mapping interfaces and centralized alarm interfacing. Some of the benefits of being able to have an alarm transferred via an industry standard protocol with a hyperlink, that can display standard reports can produce significant efficiencies for the operator. Such extra interfaces may be shared with the display server or be separate and pass the query to the database server.

## 6.4 Database hardware

This is the server upon which the database resides and manages the

- loaders
- summarization of the data (into the daily, weekly and monthly tables),
- removal of old data
- running the SQL when requested by the application
- management application to control and co-ordinate these activities and possibly notification to other applications (such as that required for automated report issue)

along with several other functions.

Depending upon the system specification (agreed to before purchase) the nightly processes may need to be finished before 07:00 (a.m.) when the engineers begin their daily work.

### 6.4.1 Data Warehouse Server

Essentially the system described with its summarization into daily, weekly and monthly tables is by definition a data warehouse. Some organizations however have a second database in which they store key data (possibly a selection or manipulation of the daily tables) as the primary user interface. This has some benefits in that the data is already manipulated and the SQL can be very efficient and reserves capacity for the database responsible for

the loading, summarization etc. Some organizations implement this architecture with the advantages that the data base type for the data warehouse may be more suitable (historic reason in general) in terms of:

- Knowledge on building procedures (such as daily, weekly, monthly Worst Cell List and table creation to store the results (discussed in section “12.5.1 Run as a nightly procedure to put results into dedicated tables” )
- Maintenance (table resizing and standard Database maintenance) may be easier due to in house knowledge of the database type used compared with that of the application
- Interfacing as well as base application license cost reduced.
- Allowed to fully control data retention policies for this critical data.
- Contractual reasons in that do not want to build into the application functions that may impact the product support

Some of the disadvantages are:

- Operational – Another transfer interface to diagnose should there be issues reported (is also in the main database)
- Another system to maintain (patching and backup)
- Network upgrades issues can significantly increase per section “5.1 We are building this and will be great”
- Not being able to simply reuse the same reports with a time period choice (day, week month) assuming you export daily data for long term use.

## 6.5 Does it all need to be split up?

The answer is in the dimensioning and the operators requirements. There appears to be little consensus within the industry.

### 6.5.1 Small systems

Small performance management systems are sometimes embedded in the suppliers OMC servers to manage a very limited amount of data and store for a limited period (often not summarizing and storing only for a few days). As an alternative to databases some manufacturers even create scripts that (for the sake of an example) will look at the last 4 days of data for a specified number counters by opening up directly the performance files for the associated time period. Regardless of the mechanism these system are looking at one manufacturer’s equipment / technology which is normally

rated up to a specified number of elements. The load placed on such servers is therefore very predictable and manageable.

It is unlikely that the equipment Manufacturers (that configured the OMC) will allow an operator to suddenly double the amount of raw data storage, query the whole network to show an aggregated performance over all data stored, or allow indiscriminate interfacing (set up an external query that shows some data every 10 seconds) as this may load their system and interfere with the other (main) functionality associated with the OMC.

### 6.5.2 Larger systems

The larger systems by contrast to smaller systems may take the performance files from many data sources (as outlined in section “4.1”) and a variety of network sizes. Doubling the size of the network will have an impact (that will not be a linear) and made complex by the different data retention strategies that may be specified. Add to this the fact that there are many interfaces to deal with in a larger system and therefore the variables become significant and far more difficult to estimate.

## 6.6 Backup considerations

As a telecom operator investing in such a system it is almost certain that you will be using a backup system for the IT infrastructure and databases. Regardless of the type of Backup system (such as Legato, or Veritas Netbackup) you will purchase a backup module license for the Performance Management System database and may require something for each server. The backup will normally be configured with several profiles to back up the:

- Operating system and application (i.e. everything except the database) and the
- Database separately
- Not back up certain directories at all. This is because the file system areas used for the data extraction and parsing are not usually worth backing up as the files there may only exist for seconds as they are parsed and be recoverable from the OMC in an emergency.

### 6.6.1 Database layout

The one thing to note is that the backup policies should be evaluated very early in the system design particularly for the database(s) layout. In the case of Informix the concept of spaces exists and in Oracle the concept is known as tablespaces. Essentially the database vendors make it possible to backup the spaces in parallel. How many parallel feeds will your Backup

administrator allow you to use? The impact can be enormous and from a practical example a database instance that was configured with one space took 18+ hours whereas breaking it into 6 database spaces reduced the time to around 2 hours.

The time taken to perform the backup may itself have an impact on the number of changes that are performed within the database so that the record the changes within the database between the start and end of the backup may be significant and further impact the duration (remember we are loading a lot of data and altering many tables every hour).

### 6.6.2 Full or Incremental

We have seen the calculations of how quickly the data can change for just a single table per section “4.3.7 Extraction”. Backup systems can be configured to backup just the changes since the last backup (referred to as an incremental backup). The rate of change of the database means that incremental backups may take a similar time to perform as full backups. If a restore is needed then restoring the most recent full backup followed by the incremental backups may mean that incremental backups are not desirable. A tradeoff is also required as to the frequency of the backup.

Depending upon the time of the day the database is backed up the daily, weekly and monthly sections of the database may be static while the raw or hourly tables are always extremely dynamic.

Systems that are designed such that the static areas (such as the daily, weekly and monthly section) can be backed up separately from the raw have not been seen in this type of application from the vendors reviewed.

If the database is not arranged based upon the time storage (some allocated to raw data storage that have constant changes while other areas with the slower changes daily, weekly and monthly table in other areas) should there be a different space or database for each technology?

### 6.6.3 Frequency

Should a full system failure occur and a database restore be required then some estimate is needed to determine the time this will take. Factors that influence the time to restore include:

- The time taken to decide that a restore is required,
- Availability of the backup servers,
- Time to restore (experts for your backup system may advise the likely duration based upon for example double the backup time),

- Time to recover the data from the data source (i.e. collect from the OMC /Network equipment or from the parsers directories where they may be saved),
- Time to reload the data (from when the system failed)

all need to be considered to make a decision

### 6.6.4 Live or stop the database for backup?

This is not normally a decision that is required (as modern databases are backed up live now days) but does your organization have a downtime requirement for the PM system? Older systems required the database to be stopped which is generally not acceptable now days when they are used to provide performance based network alarms (so that corrective action can be taken on the network).

### 6.6.5 Backup Skills

Most Telecom organizations will have a Unix support and Database Administration team. If the database type is not standard does the Performance Management vendor or system integrator supply the required skills and training to integrate a backup solution into your organization?

### 6.6.6 Backup conclusion

Regardless of the database configuration that is designed and adopted the backup must be considered before the supplier arrives on site to do an installation. It is pointless implementing a system with all the counters as described in section “11.1.3 All Counters summarized.” if it cannot be backed up.

## 6.7 Capacity considerations

As outlined in section “5.2 The data supply is regular and reliable”, the capacity of the system to cater for the surges becomes important. This in itself can be extremely difficult. The ability to recover from a full weekend outage of data flow within a reasonable time period (say up to date by Tuesday morning based on the weekend outage) means that the capacity should be available to process the weekend (Saturday and Sunday) as well as the Monday data (i.e. 3 days of data including summarization etc) in around 24hours. The capacity to accomplish this can be challenging. Should this capacity not be in the system then significant costs can be incurred when employee “on call costs” must be considered.

## 6.8 When is the Hardware busy

The hardware is busy continually although load will vary based upon data surges and utilization within the organization. A typical activity profile may be as shown below:

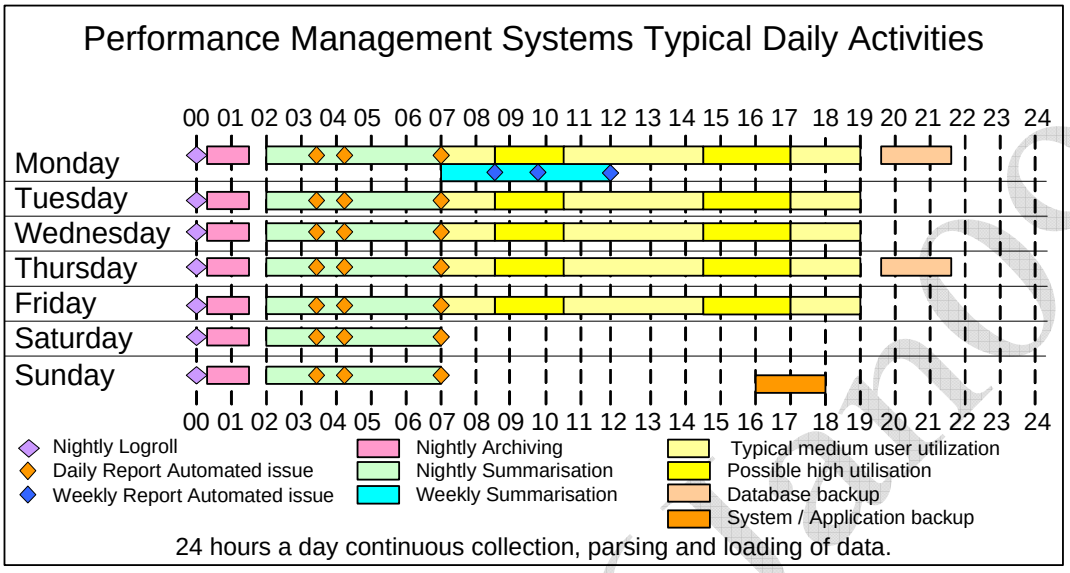


***Figure 5 Typical Daily Activities Performance Management Systems***

While the above schedule of daily activities looks nice and orderly it could be that:

- The nightly summarization takes until 10:00 (and users want their data by 07:00)
- Nightly archiving takes 3 hours so must be configured to start at 22:00
- May wish to ensure log roll does not clash with archiver (so the archiver log represents one complete day of archiving)
- The 1st day of the month may match the first day of the week meaning that occasionally the system must do Daily, Weekly and Monthly activities (and system needs to be dimensioned so it can do all that in the one day)
- The system may be accessed by users 24x7. For example if a trunk has a capacity issue the analysts may be refreshing reports very regularly (in fact some applications can be set up to refresh a report every 5 minutes)
- Late night outages (say 22:00 ->) may prevent the daily data being loaded before the summarizer starts. Depending upon work practices that may eventually be established by the engineers (they may insist

on working with daily data for first run reports) planned outages may be rejected between 22:00 and 07:00. This is good for the administrator as that means outages must be around 12:00 (midday i.e. no midnight work).

## 6.9 Hardware decision

Regardless of what decision is made, the hardware considerations can be a source of frustration to both the supplier and purchaser.

From the suppliers perspective the purchaser cannot even:

- Advise how the system will be used
- The reliability of the data supply
- How the data supply will be configured (in terms of formatting choices and number of files per hour),
- May have no idea of the number of reports expected
- Has no idea as to the complexity of the reports and queries they will generate (as they do not know the database structure). Even if they do have sample reports the answer will most likely change dramatically as both parties rarely count on the fact that a good, easy to use application will increase the demand and result in significant higher load.

From the purchasers perspective the feeling could develop that the supplier appears not to know the performance of their system and question the suppliers' competence. They may even feel that the supplier is asking so many questions to set up the defense well in advance as to why it does not work at acceptance.

Worse still is that this lack of communication can result in the supplier trying to "gloss over" these considerations to ensure the purchaser maintains confidence (or maybe they will not purchase). The supplier may then be forced to take a guess and undersize the hardware or reduce the complexity to keep the CAPEX down for competitive reasons.

Normally in the end the decisions will be made and a system installed. If a single server architecture was adopted and the network grows, additional capacity may be purchased as either more capacity (CPU / Memory) or a parser server added thus changing the architecture (which demonstrates that the decisions made are not necessarily rigid).

As a general consideration, the recent advances in IT architecture and operating system tools which are capable of allocating priorities to different

users or processes make it is difficult to see why the dividing up of the server into multiple hardware platforms should be a mandatory requirement.

# 7 The Collection Performance

This is possibly the easiest part of the system but even here there are several things that go wrong.

On small (but physically separated) system where the equipment/OMC vendor is the Performance Management vendor then common disk mounts are sometimes used. Mounting the disks of another server, when they servers are not the same network vendor, is often contractually and logistically difficult to manage. In addition disk mounts may require reboots of servers in a specific order. When there are multiple vendors and / or many data collection points as is the case in larger systems the practice becomes unmanageable.

Normal transfer practice is to:

- Have a timestamp that signifies when the last extraction took place
- Collect the newer files from the collection directory and
- Deliver them to the server where the parser is located.

Some of the issues that may be seen include:

- Breaks in data communications (poor network to server configuration may result in the file transfer error checking working correctly).
- Firewall performance – may result in insufficient throughout (and may need to bypass)
- Transferring files one at a time. The transfer of a file with security systems involves setting up a trusted host relationship and validating the trust on each occasion resulting in an overhead of say 1 second per transfer. If we calculate the number of files to be transferred (based upon 6 file types x 60 Network Elements x 4 per hour) per interface it could be 1440 files per hour for one interface. At one second per file to check security this equates to roughly 24 minutes per hour checking the file transfer permissions. As such the files are often put into one larger file, transferred and extracted at the destination.

Usually the extraction /retrieval of the data files is one of the easier area's for the system integrator but as discussed can cause issues.

# 8 The Parser performance

The file formats are constantly changing with the introduction of new IT standards. The current range of files formats includes Hexadecimal, Binary, ASCII, XML. This variety of different file format each has a different impact on the processing load and performance.

The formatting within these standards varies which can lead to issues such as the length of the lines (mean the files cannot be opened with the Unix operating system standard text editing tool "vi"). The important thing for the administrator is that they can see the contents of the file with 100% certainty. In this respect it is important that a file reader is supplied (preferably by the Equipment vendor) with whatever file format is provided such that they can be used on both the Unix/Linux or Windows platforms. In many cases the equipment vendors only supply a manual and significant investment is needed to view the contents of the files.

As described in section "5.2 The data supply is regular and reliable", the parser needs to cope with large variations in flow rate. Should something go wrong with the extraction there may be a retrieval of all data from the Vendor (possibly 4 – 10 days). Is the parser able to cope? This depends upon the architecture of the loading mechanism to which the parser must support.

## 8.1 Large numbers of files

The parser will be taking the files, joining them with topology files and possibly combining 15 minute data files into an hour. If we consider

1 15 minute data file
x 6 performance file types
x 4 per hour
x 24 hours per day
x 7 days of data (can be more or less)
x 60 data producers (e.g. 60 BSC's in the Network)
= 241 920 (i.e. ~1/4 million) files (and would be over that if it was 10 days)

These files may be delivered in relatively short space of time to a preconfigured directory.

### 8.1.1 Impact on server operating system

The sorting ability of a Unix system begins to get impaired when a large number of files are in a single directory. Some personnel indicate this occurs after around 30 000 files (however the authors experience indicates it is much higher but has not performed a full analysis). In the example

supplied we are considering around 1/4 million. The result is that Unix commands like “ls”, “find …..” or “rm *14Mar08*” become unresponsive or simply will not work. The search facilities to find the 4 files of a given hour to combine them together may simply not work and the parser can lock up.

### 8.2 Order of processing

What is your priority for parsing? Is it the oldest data first or will you accept some sort of alpha numeric priority? This could mean that when the system is at capacity one BSC (with the highest alpha-numeric naming order) is simply not processed.

### 8.3 Possible Solutions

A smarter design for pre-parsing may be to automatically create subdirectories (with a name such as 20080501 i.e. YYYYMMDD) to keep the number of files in a given directory to a manageable number. The vendors should provide some solution should the customer decide that such a risk is unacceptable.

One of the problems with such a mechanism is the lack of standardization by the equipment manufacturers in that the file naming conventions adopted may not even contain a date.

### 8.4 The resultant performance

If the assumption has been made as outlined in section “5.2 The data supply is regular and reliable” and it is not, then you may see the system lock up on a regular basis.

Per the introductory section, the parser manipulates the data such that it is suitable for loading. The parser is therefore something that is specific to the vendors’ database structure, loading architecture / design.

## 9 Loader performance

This is very closely related to the parser and partly covered in section “8 The Parser performance”. If the vendors’ architecture was:

- To load the entire network from one file the result would be that the loader may take significant time and memory to actually perform the task of loading the single file of data. The impact may be to use excessive memory (required for other parts of the system) and the time taken will create significant delays if the administrator needs to shut down the loaders for a planed works or to attend to system faults.
- To have the parser create one file per table or per network element to make the loading and fault diagnosis easier. The number of files that

may be created in a parser or loader directory however may be such that the number of files in a directory will lock up the system (as discussed in section “8 The Parser performance”).

Fortunately the PM vendors normally (but not always) balance the design between the parser and the loader.

# 10 Summarizer Configuration

We have already discussed the common delays that can be experienced in section “5.2 The data supply is regular and reliable” and as such the summarizer needs to be configured to cater for the delays that are historically experienced in a particular network and adjusted as experience in that network is obtained. Based upon experience the Core parts of the network (in the Telecom Hierarchy) can usually be done first with the Radio Access some time later.

The automated re-summarization of data also needs to be carefully considered as if the system is configured to Automatically re-summarize the system overload from re-summarization without a configurable delay and tests to ensure data for the time period in question is not still being loaded can easily overload the system.

In some cases a method to determine the % of data loaded is available and this may part of the manual daily tasks that the administrator must perform.

# 11 The database storage and user access

## 11.1 Which indicator should we give the user access to?

This sounds like a really stupid question! Many will say the changes in IT technology mean that CPU, memory and storage have all decreased in cost significantly and this trend will only continue.

Various performance tool suppliers however have different strategies (often for the historic hardware reasons) and may have changed over time to evolve with customer demands and take advantage of the reduced costs associated with IT processing and storage. The main processing and storage strategies include:

### 11.1.1 Major indicators only

This may be due to historical reasons when Data processing was expensive. These indicators may be a combination of several counters aggregated at the parser level. These may then summarize into the daily, weekly and monthly tables.

### 11.1.2 Major indicators with summarization and all indicators for limited time.

This design is relatively common and it means that the engineers can see what the raw (single) counter values are (often to check the complex indicators) but can keep an overview of Key Performance Indicators. If there is an issue with a KPI the individual counters (say for the last 30 days) can be interrogated to see what the root cause may be.

### 11.1.3 All Counters summarized.

This is of course what we all want (and especially the Network Performance and Quality Analysts) which is EVERYTHING! Ask anyone if they have a choice between everything and a limited selection.

This perception can be reinforced when the Engineers use a new counters they perceive could indicate a specific issue or new combination of counters (sometimes across vendors and technologies such as the Packet core and the Radio network counters). Giving users such a choice however has huge implications. While we have seen data storage and processing costs decrease at a truly amazing rate this has brought with it its own problems into the Telecoms Performance management software supply and support.

### 11.1.4 Loader to Extraction relationship

If we consider the “All Counters Summarized” (All indicator Storage) we can see below in “Figure 6 All Indicator Type Storage” that the reporting of a KPI is managed by the extraction scripts. If we consider “KPI Type Storage” per “Figure 7” the reporting outputs are managed by the loader configuration. Both systems have different impacts when upgrades are performed.

#### 11.1.4.1 Upgrade impact Storage all indicators

In the case of the storage of all indicators when an upgrade is performed a column (in the example column I4) is added.

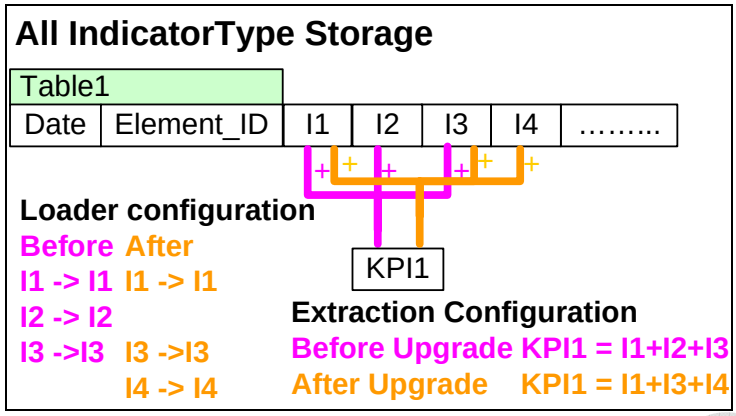


*Figure 6 All Indicator Type Storage*

The Loaders may be altered by removing I2 (as no longer used) and I4 is added. The extraction method is altered with the new formula.

The effect of this is that if trying to analyze data from both before and after the upgrade there may be only one formula available to use. Depending upon the formula should one of the counter not be available then nothing may be returned (rather than misleading results).

#### 11.1.4.2 Upgrade impact Storage KPI's

In the case of the storage of KPI's when an upgrade is performed the mapping is changed with no change to the database.

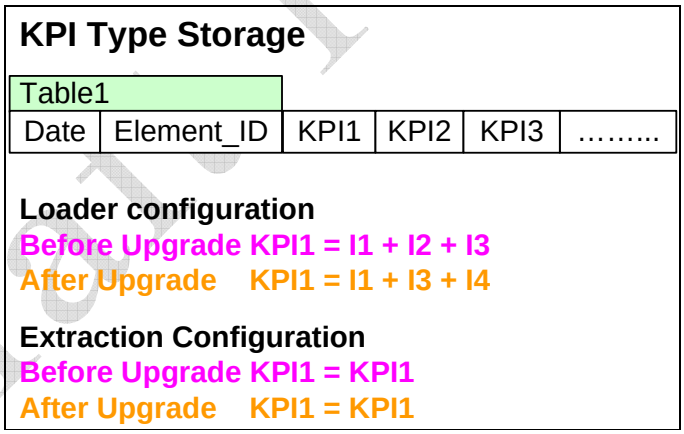


*Figure 7 KPI Type Storage*

### 11.1.5 Upgrade Impact Diagnostics

If the application formulas are written in such a way they require I3 to be a real value and not NULL then there can be some issues and nothing returned. In some applications the change after an upgrade using the architecture described in section "11.1.4.1Upgrade impact Storage all indicators" will be that a report that spans the time period where the change took place could be:

- The report will simply not work
- The results are only returned for the data after the change
- The results for before the change will be wrong and misleading
- The results may work well

This will depend upon how the formula is constructed and may be KPI1= I1+I2+I3+I4 or KPI1= I1+(if I2=NULL then 0 else I2)+I3+(if I4=NULL then 0 else I4). The most important thing is to understand the impacts of the change on the data presented.

If the application allows users to make their own KPI's a method of diagnosing the impact on the end user of I3 not being available and replaced is required. This is not provided by simply publication of the loadmaps and the ability to do some form of comparison.

### 11.1.6 Interface stability during upgrades

An example of an external interface may be to display the Performance data onto maps. Should the database be "All Indicators" then the interface also needs to be altered in line with section "11.1.4.1 Upgrade impact Storage all indicators". If the system is storage of KPI's then no interface changes are required.

### 11.1.7 Data Migration from legacy systems

If adopting a different database strategy then the migration of data from a legacy system can be extremely difficult. If the old product is stored KPI's and the new product is "all indicator" type storage then the data simply cannot split up and migrated. This may have significant impact on those managing the Network for dimensioning purposes.

### 11.1.8 What data storage strategy is right?

As explained in section "4.3.7 Extraction" the amount of data stored in a table can be significant. This has a significant impact and can lead to major problems as discussed in sections "12 Extraction Methodology", "13 Results Presentation", "6 Which Hardware Architecture is right?" and "6.6 Backup considerations" so it is well to consider this carefully.

In general a combination of KPI storage (called by the independent PM Vendors as "Vendor Neutral" which is in effect a KPI type storage system) and the vendor specific (which may in effect be "All Counters type storage") should be considered. A good knowledge of the work processes and database structure along with significant work will be needed to plan a replacement without significant disruption.

### 11.2 Database Type

The database type is normally dictated by the PM vendor but some of the considerations that the potential purchaser must consider are

- the in house expertise for support
- speed / performance and
- database storage requirements
- Hardware requirements
- Availability of Open ODBC (to connect other applications).

New types of database are available such as Sybase (with their Sybase IQ) and the product marketed by “Vertica” using new methods of storing data and “All columns indexed”. The manufacturers claim significant performance improvements in terms of smaller Server Hardware, significant reduction in storage space requirements, better scalability and much faster retrieval speeds. Vertica are already promoting their system for SS7 applications and the benefits may also be true for PM Systems.

## 12 Extraction Methodology

The extraction of the data can have enormous consequences.

If we consider most daily tables (not handover) stored for a year on a 10 000 cell network, we would have 3 650 000 rows. These tables will most likely be indexed (by the CELLID and DAY) so that the extraction is relatively quick (from the user perspective) and the database experts will usually not be concerned with these numbers. If we decide to request to see indicators related to the Traffic Control Channel, Handover, ….. we may be trying to extract off many different tables (say 20 tables).

In the explanations below we will retrieve the data to display in a report the data from 3 tables being

- Indicator1 from table1,
- Indicator2 from table1,
- Indicator1 from table 2 and
- Indicator4 from table3.

Note: the variations of SQL syntax from the different vendors (Microsoft SQL, Oracle, Informix, Sybase …) will vary but believe this should be readable to those familiar with some form of SQL.

Depending upon the database (and application functionality) the extraction process will create an extraction procedure that will work using either a:

## 12.1 Single process

This means that the application creates the single SQL that joins the tables (usually by the common parts being the CELLID and DATE columns). In order to do this it reads the tables (one by one into memory), joins the tables where it can and returns the data set requested.

Diagrammatically this looks like:

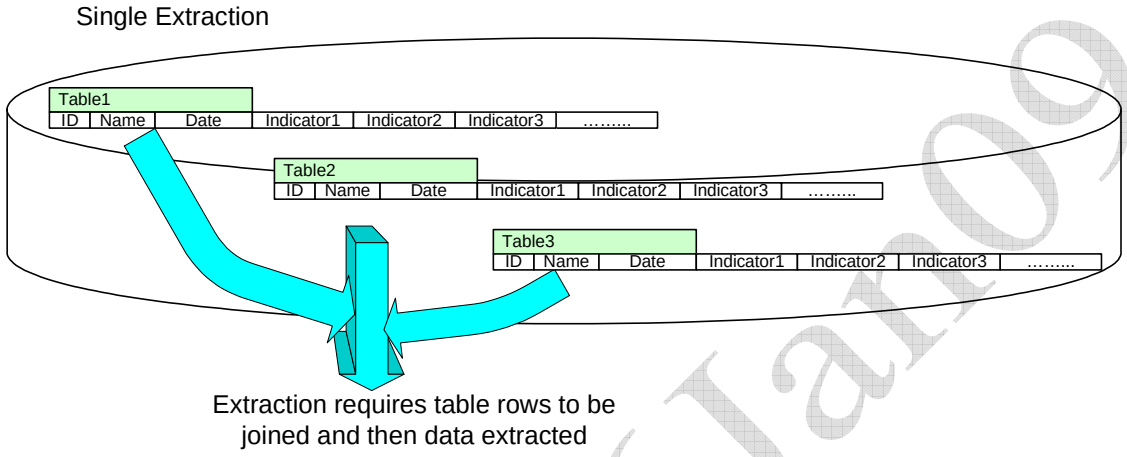


***Figure 8 Single Database Extraction Method***

This may have fundamental problems in that if we are trying to join CELLID information from one technology (say the Packet Core) with that from second technology (say the Radio) and all the data may not be available for both. Some of the issues of data availability were discussed in section "5.2 The data supply is regular and reliable" and depending upon the join conditions used within the SQL methodology it may return no results at all (even though there are results available from on of the parts of the network). In database terminology, we are looking at what is called inner and outer joins and the choice impacts the speed and if results are returned at all.

The methods of joining and the impact on the efficiency may need to be considered if this architecture is utilized.

### 12.1.1 From the SQL perspective

Select

Table1.ID,
Table1.Name,
Table1.Date
Table1.Indicator1,
Table1.Indicator2,
Table2.Indicator1,
Table3.Indicator4

From

Table1,
Table2,
Table3
Where
Table1.ID=Table2.ID AND
Table1.ID=Table3.ID AND
Table1.Date=Table2.Date AND
Table1.Date = Table3.Date AND
Table1.Date >= (??)

## 12.2 Run Multiple SQL Extraction Processes

The other common architecture is to use a 3rd party reporting engine that combines the data outside the database. This may overcome the issues of the joining methods used inside the database. Diagrammatically this looks like:

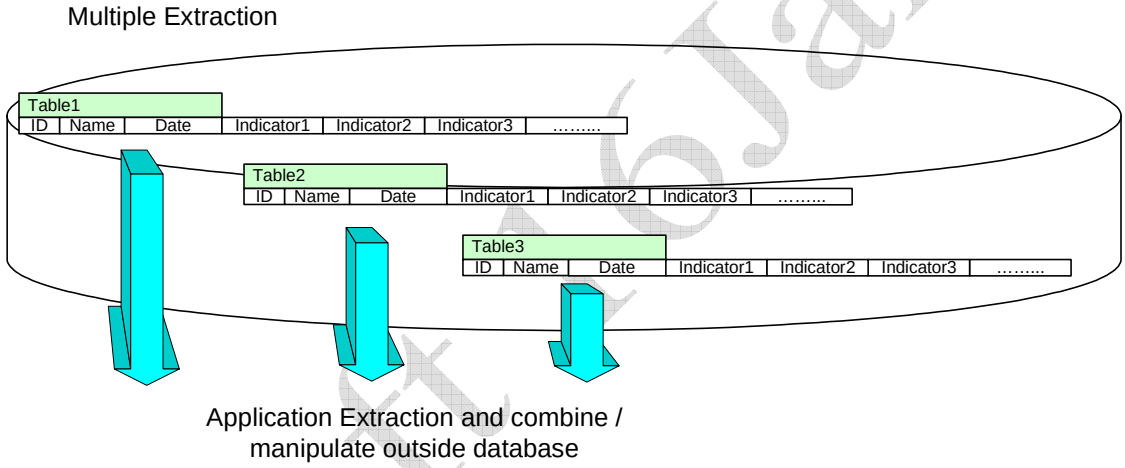


***Figure 9 Multiple Database Extraction Method***

### 12.2.1 From the SQL perspective

3 SQL's are created and run, data returned and then joined outside the database with another application:

#### 12.2.1.1 SQL1

Select
Table1.ID,
Table1.Date,
Table1.Name,
Table1.Indicator1,
Table1.Indicator2
From
Table1

```
Where
        Table1.Date >= (??)
```

#### 12.2.1.2 SQL2

```
Select
        Table2.ID,
        Table2.Date,
        Table2.Name,
        Table2.Indicator1
From
        Table2
Where
        Table2.Date >= (??)
```

#### 12.2.1.3 SQL3

```
Select
        Table3.ID,
        Table3.Date,
        Table3.Name,
        Table3.Indicator4
From
        Table3
Where
        Table3.Date >= (??)
```

## 12.3 Run multiple queries sequentially and combine

Some front end database applications will do this and perform the task very well. It is similar to the multiple queries in parallel however will run the 20 different SQL statements one after the other.

### 12.3.1 Does a special View help?

A view is a way to have a virtual table. The data itself remains in the source table(s) but allows itself to be queried just like a normal database table with SQL. Essentially it takes almost no space within the database as it is essentially a permanently stored SQL that collects the data into the format that may make it easier to extract from external applications. Diagrammatically this looks like:

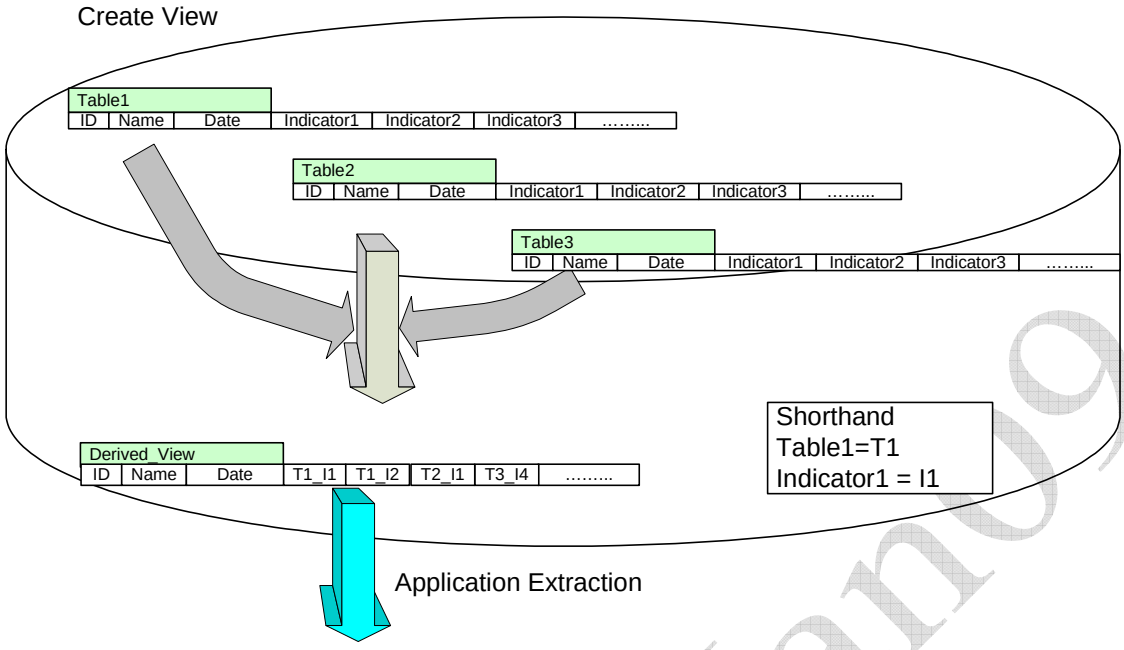


***Figure 10 Database Extraction Using a View***

### 12.3.2 From the SQL perspective

#### 12.3.2.1 Direct onto the View

```
Select
        Derived_View.ID,
        Derived_View.Name,
        Derived_View.Date,
        Derived_View.T1_I1
        Derived_View.T1_I2
        Derived_View.T2_I1
        Derived_View.T3_I4
From
        Derived_View
Where
        Derived_View .Date >= (??)
```

#### 12.3.2.2 Transformed within the database

Within the database the view creation SQL is called and the actual SQL becomes something like:

```
Select
        Derived_View.ID,
        Derived_View.Name,
        Derived_View.Date,
```

```
        Derived_View.T1_I1
        Derived_View.T1_I2
        Derived_View.T2_I1
        Derived_View.T3_I4
From
        (Select
        Table1.ID AS Derived_View.ID,
        Table1.Name AS Derived_View.Name,
        Table1.Indicator1 AS Derived_View.T1_I1,
        Table1.Indicator2 AS Derived_View.T1_I2,
        Table2.Indicator1 AS Derived_View.T2_I1,
        Table3.Indicator4 AS Derived_View.T3_I4
From
        Table1,
        Table2,
        Table3
Where
        Table1.ID=Table2.ID AND
        Table1.ID=Table3.ID AND
        Table1.Date=Table2.Date AND
        Table1.Date = Table2.Date AND
        Table1.Date >= (??)

        )
Where
        Derived_View .Date >= (??)
```

Or may be transformed into a single select with the required indicators select xxx AS Derived_View.yyy thus selecting the joining of the 3 tables

As stated above there will be alternative derivations for different databases however this should provide the required insight.

## 12.4 Single vs. Multiple Queries - Which is Best?

### 12.4.1 Processing location

If the report is requesting the Total Network traffic (calculated at cell level) for a given day then the user is after the results from a query where 2 values are returned to be displayed being the Network Traffic and Day.

- If all processing is done on the server it may be possible to only transfer from the server only the 2 values to the user interface (along with some formatting).

- If data organization is done locally (at the PC per a multiple query approach) then the results returned to the PC can be 10 000 values for the Cell Traffic (1 per cell) and Date which are then combined to display the 2 values.

This means there is a fundamental difference in where the processing is done (on the server and less data transport) or the Display device. This can also put a higher load on either the server or the data network and the PC.

From a practical perspective with the large capacity of internal data communications networks and PC processing the results may make the difference negligible (in the time taken to have the results on the display). The purpose of this paper was not to exhaustively benchmark the different architectures but explain the fundamental differences.

The answer to this question of "which architecture is best?" could take books, endless research and possibly need to go deeply into the R&D departments of the Database suppliers.

### 12.4.2 If combination of view and base tables are queried

Regardless of the benefits for extracting a single indicators from one table, if the user want to see both the indicators (tot_succ_gprs_attach and tot_fail_gprs_attach) as well as the complex indicator (available through a view) using a multiple query method the answer could be very different. If all 3 values are desired then you could have on SQL for the base indicators and another SQL which would generate its own SQL request for the complex indicator. This means the application may run the same query twice if a view is used. As discussed above in this section "12 Extraction Methodology" and in the section "6 Which Hardware Architecture is right?" the answer is that it depends.

### 12.4.3 SQL Methodology choice

From a customer (the Telecom Operator) perspective, this functionality is not something that is readily visible or selectable after purchase. The construction of the Performance Management application with its methods of query generation are made when the application is coded (sometimes years before a customer / Telecom operator sees it). Should the query generator and database capabilities not provide the required high level performance then it may never be capable. Such design assumptions may result in significant issues to try to overcome fundamental design features in the original design assumptions, costing both the customer and supplier significant money trying to rectify.

### 12.4.4 Practical Benchmark test example

The following test was conducted on a server using the manufacturers interface that joined tables and created one large SQL. The number of database tables was:

- 9 CELL Based Tables (with 38 indicators) with an
- SGSN (Packet core topology) table which was related to a CELL (Radio part topology) table which was related then to the Indicator tables.

The 38 indicators were then manipulated (mathematically often from the different tables) to create the display of the Key Performance Indicators (complex indicators) as well as the raw values. The amount of data consisted of the last 30 days of daily data. Therefore the number of rows was 30 days x 10 000 rows = 300 000 rows x 9 tables = 2 700 000 rows (with topology information added in).

While there were problems with the test methodology (as background processing could not be managed due to it being a live system), the results can be considered as indicative only but:

- Using a manufacturers' interface that generated a report to a web browser (1 large SQL and display generated on the same server)
- Using a separate front end application that sent 9 separate queries (i.e. one query per CELL table) and then formatted results on the PC. Additional test were also conducted through different client hardware interfaces however there were no significant difference with respect to speed were noted.

showed that both methods were roughly the same duration.

Note: Problems were seen with both methods due to network configuration and capacities (until rectified which was why the tests were initially run).

## 12.5 Alternate methods to have data instantly

### 12.5.1 Run as a nightly procedure to put results into dedicated tables

One option if the report is taking significant time and CPU, is to run a nightly (database) procedure and save the results to a new dedicated table. This has been done by some operators to provide daily network traffic calculated at cell level (in the example below taken from the CELL Traffic Daily tables).

The complexity of implementing such a solution with a reporting interface is dependent mainly on the Performance Vendors application that you are using. Some of the relevant factors will be:

- Can the procedure be triggered at the right time? The procedure needs to run after the summaries are done to create the data in the CELL Traffic Daily table. If there is no administrative system which activate this procedure to be run after the cell daily summaries are finished then there will often be no results or partial results returned and the system deemed unreliable.
- If there is supplementary data will the report be automatically regenerated or is there notification so that it can be manually rerun?
- Can the user front end see the new table (i.e. how does the Vendor support such customizations) so a report can be built? In particular how easily, quickly and what skill level is required to perform such a task.

Such basic questions are still to be addressed by several of the vendors.

### 12.5.2 Can it be run and the report made available

Occasionally the vendor may allow the user to run a report at specified time or for the administrator to run after a specified event such as data summarization. This may allow the automated dispatch of the report (via various formats that are outlined below in section “13.4 Ability to run reports off line when needed”).

Some of the considerations are

- Can the report generation be triggered by the data population (i.e. cater for late data)?
- Are there facilities for report dispatch?

### 12.5.3 Can report be run in Background

If reports are not needed urgently and immediately can the report be requested and run in background so the user can continue using the application for other reporting needs?

## 12.6 If we decide to investigate optimization of a report further

If we know we have a possible problem and a measurable reporting inefficiency that we wish to address, then we need to know how to proceed? The 2 areas which need to be considered are:

### 12.6.1 Specification of what needs to be done

Regardless of the solution the Application or Database Administrator (DBA) will require specific information. One of the difficulties however for the DBA will be in discussing with the users what their requirements are, specifically in terms of what they need or have in the report to see how it is extracted and work out where it is in the database. We have seen that the drag and drop nature of many of the modern data base interface tools allows the users to build very sophisticated reports. The users (Radio Optimization Engineer for example) are normally very capable of developing and testing such reports, however the rigid mathematical specification in a language the DBA may require could present the requestor with a great challenge. The ability to capture the SQL generated by the report therefore becomes essential. Often the Performance Manufacturers tool will provide a method to perform this task or the report may need to be run while the DBA traces or attempts to capture the SQL (and hopefully these were supplied with the system and the DBA is familiar enough to use them).

The DBA can then work with tools that interface with the database, to:

- Run the query,
- Review the database indexing associated with the joins etc. and
- See if there is a possibility to optimize it.

Should the manufacturers tool be perfectly optimized with the generated SQL then the benefit of such an investigation may not be significant.

Such an investigation may result in:

- Fault report / Enhancement request to the Performance Management vendor
- Implement off line or scheduled report running (if possible)

### 12.6.2 The Business case to justify the optimization

This depends upon:

- How often the query is to be used? If the report is a “once off” the answer is a definite no as by the time it is prototyped there is no point optimizing it.
- How important it is to the operator to have these questions answered immediately. E.g. will the results mean immediate action to fix a network issue to raise revenue?
- If the report is run on a separate terminal (or in the background) does it matter if it takes 4 hours anyway (e.g. Provide the BSC

performance per BSC on a daily basis from 20 indicators the CELL level for the past year)!

As such some method of logging to indicate how often a given report is executed and how long it takes is required. If it is discovered that the report was found to be run by 10 people, 10 times a month then some intervention by the Administrator is desirable on a pure cost benefit basis. If on the other hand it was only once a year then there is no real cost benefit advantage in speeding up the report.

# 13 Results Presentation/User Interface

As discussed in section "6 Which Hardware Architecture is right?" and "12 Extraction Methodology", how the results are presented is determined within the architecture and may be dictated by the 3rd party tools that the PM vendor may have chosen. Generally the choice of which 3rd party tools or web interface is not easily changed and the architectural design cannot be influenced by the operator especially after the purchase.

Many of this issues that are faced are covered in the previous sections however while the Engineer may tolerate fairly plain functional reports that contain the data they need (as long as can transfer the results to other applications for the occasional nice report) we know many other users are harder to please.

## 13.1 GUI interface

Most users expect the Windows like User Interface and excellent reports presentation. The use of 3rd party software in building such a system means that a nice interface is normally provided.

## 13.2 The report purpose and user requirements

The basic aim of a report is to assist in the making of a decision. In these types of systems the decision may be that "Network Cell looks good" so need to look at the next (neighbor) cell to see if that is why the calls are dropping calls, or whatever the issue that is being investigated. While that type of cell based report may never go further than the Engineers screen many reports will need to be communicated to others to explain or demonstrate the problem. Furthermore the information in the report may need an explanation (e.g. "this graph shows the Traffic lost due to the cell being down with the historic overlay for the same time period the last x weeks").

### 13.2.1 Ability to annotate the report

In general the reports are designed and annotation within the application is normally not possible. The ability to copy results or export the result as discussed below is therefore desirable.

### 13.2.2 Export results to other systems

The ability to "Cut and Paste" a graph or chart from the Performance Management system displaying for example "the growth of network traffic" into a report which may "justify funds to invest additional network capacity" is an important feature. On a similar basis the ability to transfer the data (as it is presented) into packages for combining with other data sources into a package such as Excel is also important.

Significant exports to *.csv are often required to display for example traffic data in a thematic map (which shades a map in different colors based upon the intensity of the activity) per section "13.3 Interface stability following upgrades". Caution should be exercised as sometimes the system may be configures to export only a certain number of records preventing such tasks from being performed.

Other formats are also important such as *.pdf as outlined below.

Email is also another way of communicating to a decision maker. The ability to provide the report as an attachment (possibly as a *.pdf and preferably in one step) so as to easily combine with an explanation is also desirable.

## 13.3 Interface stability following upgrades

Another complication arises when wishing to present the data in close to real time using mapping or web applications to say a network monitoring center. The ability to build stable interfaces that survive Technology Interface (Network Interface) upgrades becomes important. As such the stability of the database design and the interface design in the face of constantly changing counter definitions proves to be one of the challenges.

One solution may be to make all mapping interfaces pass through a Database view. This will allow relatively easy reconfiguration of the Mapping interface (simply change the view rather than reconfigure the mapping application to which the Performance Management Administrator may not have access).

## 13.4 Ability to run reports off line when needed

As discussed in section "12.5 Alternate methods to have data instantly" when a report takes several hours to run (e.g. for the whole network for the

past x years) then the ability to run the report off line and save time becomes important. Typically reports may be scheduled however due to the problems outlined in section “5.2 The data supply is regular and reliable” the ability to deal with a system and run the reports when the data is finished processing is important. Estimation of when the weekly processes are complete will simply cause issues and the need to run report again (with much frustration to the users which may include the CEO).

Typically on the Monday the publication of the weekly reports is required (as shown in the figure in section “6.8 When is the Hardware busy”). These must be delivered to the persons concerned and formatted in a suitable method. Reports issued by Email attachments or better still to a designated drives (in a format such as a *.pdf or *.csv) and notification of personnel concerned that it is available becomes fairly standard practice.

### 13.5 Multi level reporting

Engineers will want to see reports at multiple levels of the network. By this we mean that one CELL may have several TRX’s on it. The Engineers will want to see the results for the CELL and the combined TRX values (may be total and averages) along with the individual TRX results (to see immediately if cell is working and then which TRX is at fault. Similar requests will appear on the switch side.

### 13.6 Cross Vendor reporting

As discussed previously the CELL information may be coming from the Radio part of the network and the Packet core. The ability to compare the values from both systems is highly desirable, such that the system (and not just the different pieces of equipment) can work together. While many vendors have performance management system in a multi vendor environment this is a criteria for any centralized performance management system. From a practical perspective the standardization of naming conventions across the various technologies can be a major exercise.

## 14 Administration interface

Whenever anything is not available, it is the administrator that is called (i.e. shoot the messenger). As outlined in section “4.3 Main Components” there is a significant amount of activity occurring at any time. With larger system there may be thousands of summarization processes (daily, weekly, monthly), thousands of tables being archived, many loaders to monitor and not to mention the data availability for the system to collect and process. All of these activities require some level of automation such that action can be taken before the end user of the reports realizes there was a problem.

## 14.1 Prioritization of processing

### 14.1.1 Ordering of processing

As specifically discussed in section “8 The Parser performance” the order of processing becomes important. Generally the ordering of the parser will ensure the loaders are ordered correctly (but only if you can configure the loaders as First In First Out into the database) but this assumes the loader order can be configured.

The same can be applied to all parts of a system such as nightly summarization

- Can the system determine if all of yesterday’s data is loaded (in which case start summarization at that earlier time)?
- If there is still data from the previous day can the summarizer detect this and delay its start time (if configured to do so)?
- Should there be “Busy Hour” that needs to be calculated by one technology and made available to another then this introduces dependency. Is this dependency easy to configure (not applicable on small single Technology systems)?
- Reports may need to be run after certain nightly summaries are complete. Can the system be configured to run them immediately after the respective summaries are run (rather than after all nightly processing is expected to be complete)?

### 14.1.2 Priority access to CPU

Especially on a large system can the resource allocation be configured such that the summarizer (traditionally runs from 02:00 – 07:00) releases its capacity to end users during the day?

This is particularly applicable to large single platform systems as discussed in “6 Which Hardware Architecture is right?”. Can the system be configured such that the parsers, loaders or users always have some level of access to the system? If backlogs mean that the parsers (and then loaders) take all the capacity leaving none for the users then there will be a problem.

Is there some form of reserved capacity for each of the major processes where the excess is released to other major processes?

## 14.2 File available for collection

Some method is advisable to be able to quickly assess if the files were available at the place of collection (and when). The requirement for

someone to log into a system and investigate can be time consuming. Delays in providing answers to end users will become another source of frustration when simply trying to do their work. The ability for an end user to see if the data was available for the system to process is highly desirable. Does the Performance Management Vendor or the system integrator provide tools to assist?

## 14.3 File conversion scripts

The files as stated in section “4.3.1 The Performance files” may be in a format that is simply not readable. The equipment vendor should provide a supported script to convert a file. While the PM Vendor will do this task within their parser they will go much further and convert to the file format they require. Without the ability to read the raw data file it becomes difficult to verify the loader file has been created properly!

A file conversion script should be available for each interface and those responsible for purchasing the network equipment should ensure it is included with the purchase.

## 14.4 Reports on data availability in the PM system

A Performance Management system is set up for monitoring indicators. It should be possible (and normally is) to set up indicators that can tell how much data is successfully loaded on both an hourly and daily basis. Between the file availability at the source and the data loaded in the system a quick assessment as to the system performance can usually be made. Does the Performance Management system provide such indicators?

## 14.5 Logs

The traditional logs of the extraction, parsing, loading, archiving … must be in a format that can be easily assessed. Occasionally the Performance Management logs are so long and poorly formatted it becomes necessary to know what the problem was to review the logs. If you need to know what is wrong to find the relevant entry in the logs then the system is not very good.

Automated Methods to scan for the appearance of key words such as ERROR are often made to monitor systems however the configuration of Performance Management systems to ensure that ERROR is something to react upon can be challenging. Are the logs configured such that they are easily monitored in an automated way and formatted so you can search easily for problems?

## 14.6 Reports on Summarizer activity

It is important that an overview of the summarization is available and if it cannot be easily reviewed from a suitable display (such as background color coded with drill downs) within a few seconds then some form of automated analysis of the log may be needed. Does the Performance Management Vendor provide such a display mechanism and an indication of % data summarized?

## 14.7 Process monitoring

There are many process monitoring applications available in the corporate environment which can be configured to scan all the servers in the company and issue and alarm if a process is not running or disk is near full etc.

Many of the Performance Management systems run an activity until it is completed all possible activities, stop and then reactivated by the crontab at predetermined intervals. (e.g. a loader will load all available files, stop and then be restarted every 5-15 minutes for example). As such it is not possible to monitor if a process is always running (as it is not).

Should a process fail (for example due to a corrupted file) it may fail again when restarted. As such the running of such activities continually and setting up the monitoring to detect failures may be advantageous (and just restart every hour or 2 so the process monitoring detects the failure). Does the Performance Management vendor application go into continuous failures with a corrupt file?

## 14.8 Database monitoring

Is a monitoring system supplied with the system and is it fully automated? In many organizations there is sufficient skill within a database support team (providing they are set up for that type of database) with their own automated monitoring system. If however the database is not typical to the organization then some expertise may need to be supplied during the commissioning phase. Does the Performance Management vendor supply all the tools available for the database maintenance? Should some maintenance activity be required then does the maintenance represent any downtime?

## 14.9 Rebooting of services

If for example the activation of higher levels of logging (to collect greater amounts of information to determine the root cause of a fault) mean that services (or the application) need to be rebooted and all users need to be off the system for the reboot then the administrator is destined to long days

and lots of complaints. Does the Performance Management vendor specify clearly how often and for what reasons the users may need to be off the system? Do you have uptime criteria?

## 14.10 Backlogs

How frequently are backlogs detected and alarms raised? If the situation is such that you only find out during morning checks that a backlog needs to be attended to then:

- The backlog will need to be rectified
- Summarizations performed again
- Dependent report run again

and all these tasks may take significant time until the application is up to date, particularly if there is a processing limitation. Does the Performance Management vendor provide continual monitoring for backlogs? Does the Performance Management vendor provide tools to automatically recover from the backlog (by automatically activating additional loaders, rerunning the summaries and dependent reports)?

## 14.11 Report Usage Interface

As outlined in section “12.6.2 The Business case to justify the optimization” it is necessary to know:

- How often a report is run,
- Duration,
- CPU and database utilization,
- Who is running it,
- When it is run.

This will allow quick investigation if report should be investigated to for possible optimization, scheduled with automatic distribution (especially if several people are running the same report at the start of the day) and if we do know from the activity monitoring that hardly any reports are run between certain hours (of say12:00 -13:00 when staff at lunch) then we can organize outages during the quietest part or the day. Does the Performance Management Vendor supply a Report usage interface?

## 14.12 Regular checks interface

Is it easy to use? Can all the daily check be done without Unix knowledge and hence allocated to someone in a Network Supervision type role?

The use of a web based interfaces (possibly without login to show all of the administrative checks should be available at any time). Regular, Daily, Weekly and Monthly checks can effectively be ordered via links on a administrative web page. The most important thing to consider with a system in production 24 x 7 is:

- that it will take time to catch up if falls behind,
- that users need to be back to work quickly to do their daily work,
- where users and management are demanding their reports immediately it is essential that the problems can be quickly identified (preferably before the users are aware),

Does the Performance Management Vendor provide tools to assess a problem quickly? Are the tools supplied able to show where the problem is located and can it be done within minutes of the problem being identified?

## 14.13 Security policies

While each company will have its own security policies these may be applied to the:

### 14.13.1 Deployment phase

Items such as protocols for data transfers and firewall configuration with performance will need to be specified pre-contract depending upon the organization.

### 14.13.2 Standard password management

Password policies such as how often a user is to be forced to change their password or the ability to link the password to a centralized system (managed by your Windows Administrators or other group) should be considered. Policies that force password changes while good can result in significant manpower lost and time spent re-issuing access passwords.

### 14.13.3 Data access

Performance Management systems allow the user to run reports such as “Traffic per month per network node (e.g. a BSC) or the entire network” As such day time restrictions to access of data are sometimes requested by security staff or even the access to the sections of the network the users are responsible (and deny access to other areas).

Does your organization have data access restrictions and does the Performance Management vendor support your policies?

# 15 The future of PM systems

There are various initiatives for the future Mobile Telephone networks that will influence Performance Management Systems.

## 15.1 Element Managers

The future when considering the management of equipment within equipment dedicated Element Management Framework may change but the need to manage and assess the performance of the elements themselves will remain into the foreseeable future.

## 15.2 Increasing numbers of cells

We have already seen home based devices that allow the connection of the mobile phone to the Mobile network and facilitate the handover of calls as the user leave the home. Convention centers and many large offices often have what is marketed as micro or pico cells with handover capabilities to the larger traditional Network Cells. Especially for the existing Radio Access planning and support personnel, we should consider the situation where there is a cell in every house and small office that can be switched on and off without consultation with the provider!

## 15.3 SON (Self Optimizing Network) Architecture

SON architecture involves the ability to remotely adjust the Antenna tilts and parameters. While the network parameters are changed on a regular basis (say once every week or two a new plan may be run), the proponents envisage this will not be sufficient and fully automated self calibrating networks will be developed in the future (and some operators asking for this in 4G specifications). The ability to change from half to full rate (i.e. alter some parameters that impact capacity and quality when sudden overload conditions occur) may be another simple example.

SON architecture requires far more experience and knowledge than what can be presented in a paper such as this, however several considerations can be mentioned.

### 15.3.1 Impacts of SON and increasing numbers of elements

The problems already impacting the processing of Network performance data are apparent. These problems will become more critical in the future and some fundamental changes may be needed. The need for reliable Network performance information and the speed at which it is to be processed will require some changes in the way it is processed. In the authors opinion some standardization will be mandatory.

### 15.3.2 Centralized vs. Distributed Processing

The current architecture that the PM system is centrally located as shown in “Figure 4 Performance Management Data Flow Diagram” and used for optimizing the whole network with a SON architecture may be impractical and optimization at a more localized level (i.e. the neighboring cells exchanging data and making pre-programmed adjustments) may be required. To allow such data transfers standards for all vendors will be essential and may need to become a similar dataflow method to that of call handover management. Should this be the case then a base set of indicators (with a standardized KPI performance file generated locally and a secondary vendor specific indicator file) is just one of the questions that will need to be addressed.

### 15.3.3 Performance File Generation Priority

The prioritization of the performance files at the moment is that it has the lowest priority of the Telecom equipment as discussed in various sections (such as the section “5.2 The data supply is regular and reliable”). This will most likely need to be increased and current practice of not bothering if a system is underloaded or overloaded no longer permitted. If a file is not produced, what impact will that have on a SON based architecture? Is SON architecture to assume when there is no data that the cell has failed, been switched off or no traffic and therefore need to reconfigure that part of the network?

### 15.3.4 KPI Standardization and creating multiple performance files

Standardized KPI’s and formats that become meaningful between vendors will almost certainly become an industry requirement. This would facilitate direct exchange between the various network elements (e.g. the controller or Cell 1 from vendor 1 to the controller of Cell 2 from Vendor 2 when discussing radio / GSM type situation) without the overhead of trying to read all the different manufacturers and their counters in their formats.

As such it is likely that equipment will need to produce an industry standard file with industry with agreed complex KPI’s that are vendor independent and in a standardized format. The collection of the rest of the counters that the vendor wants for their equipment will most likely need to be done in a separate file and probably processed with the established (current) methodology.

# 16 The need for industry standards

One of the stated aims of the TMForum in terms of their TIP working group is to introduce standards to facilitate a reduction in integration and operational cost.

This paper has outlined some of the problems faced in the analysis of the performance files created by the various equipment used in the industry and the problems often faced. While the performance files are normally well documented and in a standard ASCII, XML or other reasonably well understood formatting the need for greater standardization is still required. Some basic topics should be discussed at length to evaluate what should be done and the benefits that may be gained from introduction of recommend standards such as:

## 16.1 File naming

### 16.1.1 First 6 sections of the name

Such convention which need to be discussed and determined may be that Performance files names should start with the:

- Date (YYYYMMDD) and
- Start Time (HHmm) The first start time as some vendors concatenate multiple time periods into one performance files should there be break in communications and the files not dispatched.
- Element Type (ET) e.g. MSC
- Element ID (ID) e.g. The MSC designation which is usually an abbreviation of the Physical location.
- Counter Group (CG) e.g. PM110 may be the Cell performance files and PM180 may be the Handover performance files. The groupings of the counters appears to have no standards between one manufacturer and another.
- Version Number (VN) e.g. v16. This allows the easy identification for the transfer to ensure sent to the right directory and processed by the right parser. During network upgrades 2 different software versions often need to be handled simultaneously.

Leading to a designation in the following format
YYYYMMDD.HHmm.ET.ID.CG.VN.xxx

### 16.1.2 Must not use certain characters in a name

File naming must not include characters that are restricted in a Windows environment. As such the use of #!%:? …. This is simply to allow the administrators to look at the file through their Windows based PC!

## 16.2 File Formats and contents

As discussed in section “4.1 What are the Performance Management Systems covered in this document?” and section “8 The Parser performance” the contents of the files in terms of the vendor specific counters may not be able to be standardized but some of the basic headers, start time (UTC is normally used), End Time and inclusion of other basic information in a standardized format could be helpful.

While some of the proponents are already suggesting XML standards should be the industry adopted standard this paper is not prepared to prescribe the solution but raise awareness and discussion that the costs of maintaining the number of interfaces and without standards has an impact which may act as a catalyst for discussion and changes.

## 16.3 Counter Documentation

As discussed in section “5.3 They are simple file formats to process” the format of the documentation may lend itself to standardization to allow greater level of automation in the creation of the database and user interfaces. Documentation could be issued as spreadsheets (e.g. Microsoft Excel) to contain:

Sheet 1 – Single indicators

- Counter Name (That is in the Performance file)
- Counter Short Name – This is a readable name that should consist of ??? characters for compatibility with column names in the database
- Counter Format (e.g. Small Integer i.e. 8 Character).
- Counter Description – This is the long description that can be fed into the Help file of the application
- Counter Active (Yes/No)
- Counter change history (became active/obsolete version and date so ~256 Char text field)
- …. ???

Sheet 2 – Complex indicators

- Complex counter
- Complex counter name – Keep less that ??? characters for compatibility with column names in the database.
- Complex Formula – This is the recommended formula

- Complex Formula description – This is the long description that can be fed into the Help file of the application
- Complex Formula Active (Yes/No)
- Complex formula change history (version and date so ~256 Char text field and/or formula change)
- …. ???

### 16.4 Start time of files

As outlined in section "4.3.1The Performance files" the time duration of the files may vary. One thing that is however important is that the equipment manufacturers ensure that the start time of the performance file can be synchronized with the hour i.e. xx:00:00. This will allow:

- That there is no statistical approximation performed when loading the data. An example would be that if the start time of the PM file matched when the PM file was activated (or some other equipment operational variable). This may mean that the performance file set to be produced every ½ hour may start at xx:12:00 and finish at xx:42:29. The approximation carried out may be that 12/30 of the previous corresponding performance file and 18/30 of the current file which would be loaded into that half hour time period within the database. As the Network Equipment ensures time checking etc such statistical approximation can and should be avoided in the production of the PM statistics files.
- Simple aggregation within either the parser or within the database itself to produce the time granularity that is desired (e.g. the performance management system may desire 24 individual hours of data).

## 17 Lessons Learned and the way forward

The lessons learned from the difficulties to date (highlighted in this paper and the industry experience with 2/2.5/3G interfaces) are unlikely to be ignored such that the ability to process data in a standardized way will become more critical. For example:

- Some vendors currently do not produce a performance file if there is no traffic and as such will the PM system assume the element has been removed from the network or switched off and the SON system compensate automatically creating undesirable network changes.
- How will the SON architecture achieve it goals if there are no standards (e.g. standard indicators)?

- How will the ever increasing networks be tuned to allow SON type architecture if standards are not in place for reconfiguring the cells with an open standard?

While it will take the talent of many people throughout the industry to develop the appropriate standards such work will be essential moving into the future.

In light of the problems highlighted by the industry the TMForum has begun a study in 2009 within the TIP working group to further validate, explore the issues and determine the actions to be taken. It is hoped that this will ensure many of the problems described in this paper can be avoided in the future.

### 17.1 Why is this important to the Operator?

As more services and equipment network complexity increases the ability to quickly and efficiently (both from a technical and cost perspective) integrate them into the quality management systems will become more important. The current costs of integrating and validation of interfaces into the existing systems has at times been seen to be cost prohibitive.

The introduction of standardized documentation and file formats may allow the manufacturers of Performance Management systems (and their integrators) to build tools to generate such interfaces and databases with greater efficiency and accuracy to reduce both the time to market and cost.

From the Telecom providers end consumers perspective, if a service is offered it is expected to simply work! While the technicalities and issues discussed in this paper should never be known to the handset user the operator must ensure the base quality of the services it offers to its customers. Ignoring the quality provided to that customer will be done at the operators' peril.

## 18 Acronyms

ASCII - American Standard Code for Information Interchange

ATM - Asynchronous Transfer Mode

BSC - Base Station Controller

BSS - Base Station Subsystem (note this is an industry standard definition and consists of the Base Station Controller and Transmitters). The typical use within TMForum is Business Support Systems)

CAPEX - Capital Expenditure

CDR - Call Data Records

CEO - Chief Executive Officer

CPU - Central Processing Unit (on the servers or personal computer)

DBA - Database Administrator

eTOM - Enhanced Telecom Operations Model?

FW - Fire Wall

GIS - Geographic Information System (Mapping Application)

GGSN - Gateway GPRS Support Node

IT - Information Technology

KPI - Key Performance Indicator (vs. Performance Indicator or Key Quality Indicator)

MSC - Mobile Switching Center

NSS - Network Switching Service

ODBC - Open Data Base Connectivity

OMC - Operations and Maintenance Center (from the equipment suppliers perspective this is normally a server that allows the configuration and monitoring of the equipment including the user interface).

OPEX - Operational Expenditure

PDF - Portable Document Format (Developed by Adobe)

PM - Performance Management

RAC - Routing Area Code

RNC - Radio Network Controller

SGSN - Packet Core

SMS - Short Message Service

SNMP - Simple Network Management Protocol

SON - Self Optimizing Network

SQL - Structured Query Language

TAM - Telecom Applications Map

THS - Telecommunications Hub Site

TRX - Transceiver – Transmitter and Receiver

UTC - Universal Time Co-ordinated

vi - A Unix Text editing tool/program (abbreviation of Visual In)

VM - Voice Messaging

XML - eXtensible Markup Language