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# Crystal Analysis Technical Overview

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- ▶ *A Complete Review of the Core Technologies and Functionality Available in Crystal Analysis*



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# Contents

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<b>Overview</b> .....	<b>.iv</b>
<b>Decisions Power Business</b> .....	<b>.1</b>
<b>Introducing Crystal Analysis</b> .....	<b>.2</b>
<b>Easy Report Creation</b> .....	<b>.3</b>
Free Form Layout .....	.3
Powerful Analysis .....	.3
<b>A Flexible and Powerful Tool</b> .....	<b>.7</b>
Client Choices .....	.7
Asymmetric Reporting .....	.8
Changing Member Display .....	.8
<b>Powerful Analysis</b> .....	<b>.9</b>
Advanced Navigation .....	.9
User Calculations .....	.11
Exception Highlighting .....	.11
Color Coding Using a Calculation .....	.12
Filtering .....	.13
Sorting .....	.13
Data Analysis .....	.13
<b>Highly Scalable</b> .....	<b>.14</b>
OLAP Scalability Challenges .....	.14
<b>Support for OLAP Server Functionality</b> .....	<b>.16</b>
Cross-Platform Support .....	.16
Crystal Enterprise Architecture .....	.16
Intranets, Extranets, and Portals .....	.17
<b>Built on an Extensible Platform</b> .....	<b>.18</b>
XML File Format .....	.18

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## Overview

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Crystal Analysis® delivers OLAP-powered guided analysis that enables business users to easily gain insight into their business data and make intelligent decisions that impact enterprise performance. Through a drag-and-drop design environment and rich visualization techniques, users can build and modify analytic reports without having to rely on IT. Tight integration with Crystal Enterprise™ allows analytical reports to be viewed through an intranet, extranet, or corporate portal. Supported servers include: Microsoft SQL Server Analysis Services, Hyperion Essbase, SAP Business Information Warehouse (BW), and IBM DB2 OLAP Server.

In this paper, we'll review some of the key technologies and features of Crystal Analysis and find out how this product helps users meet the challenge of getting actionable information into the hands of a variety of users—inside or outside the organization.

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## Decisions Power Business

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In a recent BusinessWeek article, John Chambers, CEO of Cisco Systems, was quoted as saying “Quicker decision-making at lower levels will translate into higher profit margins. So instead of the CEO and CFO making 50 to 100 different decisions a quarter, managers throughout the organization can make millions of decisions. Companies that don’t do that will be non-competitive.”

Chambers’ comment identifies one of the key challenges facing organizations today—the ability to make decisions needs to be pushed down the organization. By allowing line-of-business managers to make fast decisions, the company will get a more competitive edge. But for decisions to be effective, they must be driven by hard facts. In other words, actionable information must be delivered in a timely manner to the right people, in a format that highlights problems and invites further analysis.

One of the key enabling technologies for delivering this kind of solution is online analytical processing (OLAP). Analytic report analysis enables exploration of summarized OLAP data, allowing analysts and end users to uncover hidden trends and patterns not always evident in relational reports.

Historically, analytic reports have been confined to business analysts and so-called power users within an organization, using thick-client slice and dice tools that require intimate knowledge of how multi-dimensional data works. This is at odds with the vision of empowered line-of-business managers making better decisions through targeted information and further analysis. To deliver this vision, it is necessary to move beyond traditional analytic report client tools.

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## Introducing Crystal Analysis

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Crystal Analysis is designed to make analytic reports accessible to every user in an organization. Analysts and developers create interactive snapshots of analytic report data and link them together into web-based analytical reports for guided navigation. The resulting reports are perfect for general business users and management—both of whom often have reservations about using a raw slice and dice tool.

For more sophisticated users, Crystal Analysis exposes a wide range of advanced analytical features including powerful formatting features (e.g. exception highlighting), formulas and calculations (e.g. variance), and data visualization (e.g. charting). All of this functionality is available through context-sensitive menus that can be toggled on or off by the administrator.

Crystal Analysis offers two ways to present your analytic reports over the web: an ActiveX rich-client and a DHTML zero-client web interface. Crystal Enterprise provides secure, scalable distribution of analytical reports through the internet, intranets, extranets, and corporate portals.

# Easy Report Creation

Anyone with a general knowledge of the data and a series of questions they need to answer should be able to build an analytical report.

## Free Form Layout

Crystal Analysis offers a visual drag-and-drop environment for power users to rapidly assemble rich analytical reports. Objects are placed freely on the page and may be resized independently as required.

Once a report is created it can be locked, preventing users from changing the objects on the pages, while still allowing the analytical features (such as drill down, pivot, calculations, etc.) to be used.

	Actual	Variance(Act vs Bud)
All Products	1,822,174.72	22,219.43
Bakery	132,349.05	3,223.24
Frozen Goods	69,829.31	-3,192.72
Fruit and Vegetable	348,743.28	275.06
Fruit	105,933.47	-3,536.80
Vegetables	162,009.01	3,011.05
Grocery	771,639.60	3,696.22
Meat	261,039.39	9,725.64
Wine and Spirits	138,564.27	0,290.89

## Worksheet

In addition to displaying OLAP data in a tabular form, the worksheet offers the primary user interface for manipulating the data through drill down, slice, and pivot operations.

Right-click menus give access to analysis options such as calculations and exception highlighting, which are described later in the section

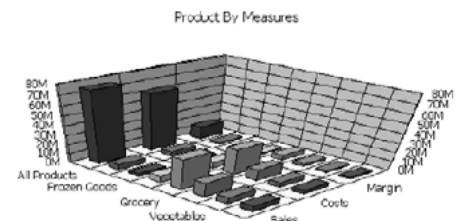
Product	Sales	Costs	Margin
All Products	75,652,455	62,028,936.45	13,639,632.46
Bakery	5,607,353	4,541,470.62	1,067,147.32
Frozen Goods	2,513,552	2,211,028.95	304,408.36
Fruit	7,778,654	6,571,428.10	1,208,238.46
Grocery	32,418,388	27,029,775.76	5,395,617.45
Meat	14,472,874	11,898,853.34	2,588,393.41
Vegetables	6,646,540	5,307,705.43	1,541,593.57
Wine and S...	6,013,194	4,490,669.25	1,534,197.92

## Powerful Analysis

All of the navigation and analysis capabilities are available through the keyboard for improved accessibility.

## Chart

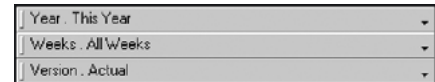
The chart object provides a wide range of data visualizations from simple line, bar, pie, and area charts to more sophisticated representations such as bubble, radar, and spectrum charts. A powerful dialog system allows the user to choose from a gallery of predefined chart styles or customize the current chart. Customization options include font control, number and style of axes, number format, and viewing angle.



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## Slice Navigator

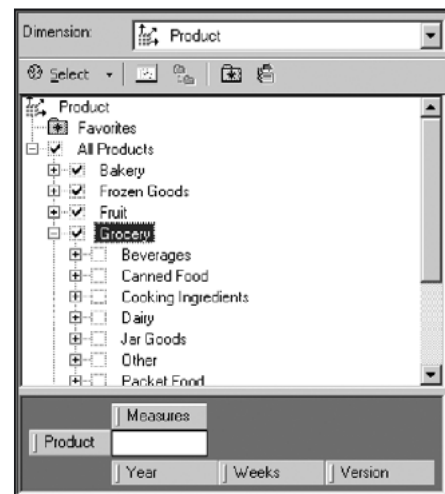
A slice navigator groups together all the dimensions that are not in the rows or columns of a worksheet, or in the axes of a chart. This allows the user to easily change the data displayed in a page (for example from displaying data for week 20 to week 39). The slice navigator enables users to choose which member to slice on.



The slice navigator object is also used in the worksheet object and can display the slice dimensions vertically or horizontally. If required, the slice navigator will scroll to allow for many slice dimensions.

## Dimension Explorer

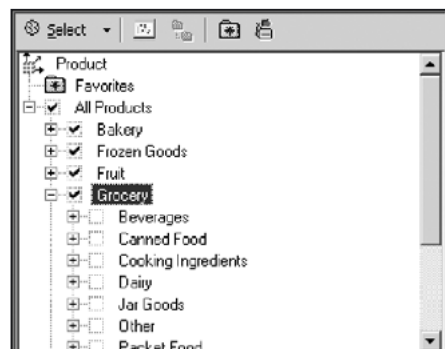
The dimension explorer combines many navigation options in one object. A member selector is embedded in the object, along with a drop down list (combo box), to choose which dimension is represented in the member selector. A pivot control, found beneath the member selector, allows the dimensions to be laid out as required.



This control provides an extremely compact way of providing full navigation, particularly in combination with charts or worksheets, which have been customized to the point where they are just tables.

## Member Selector

The member selector allows the user to choose which members are displayed for a given dimension. The dimension is displayed in a tree, indicating the dimension hierarchy. The conventions used in Windows tree controls can become inconvenient when selecting a large number of members—it's very easy to accidentally lose a large selection by forgetting to use shift or ctrl when clicking. A more scalable solution would be to use check boxes next to the dimension member, as in the Crystal Analysis Member Selector.



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The member selector is specifically designed to manage large hierarchical dimensions, so it has sophisticated options for selecting groups of members and for dealing with dimensions that have multiple hierarchies. Alphabetical sorting options make it easy to find specific members in large dimensions.

### Analysis Button

Analysis Buttons allow a report creator to produce a guided analysis experience, or workflow, in an analytical report enabling report users to easily navigate through the report pages and change the displayed data. For example, if a page in an analytical report highlights that the product group margin is unacceptable, an analysis button can be used to take the user to a new page to investigate the product group margin in greater detail.

The key difference between Crystal Analysis and conventional briefing books is that the Analysis Button carries context between pages of the book, making it simple for the user to follow a train of thought when analyzing a problem.



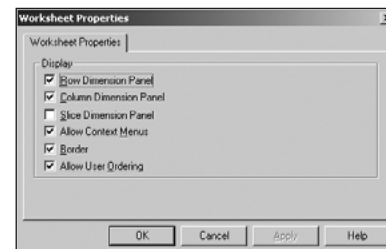
### Text Objects

Text objects can be used to add any required text to a page, like instructions for the user or an explanation of the displayed data.



### Object Properties

Each object has a property sheet that can be used to tailor the behavior of each object (worksheet shown), like removing advanced functionality to make the analytical report easier to use for less sophisticated users.



### Automatic Object Linking

Crystal Analysis automatically links objects on a page to the chosen OLAP data source. This gives a live design experience where the actual data is displayed while building the analytical report. It also ensures that the all objects on a single page are kept in step so that they all display the same data and dimension members.

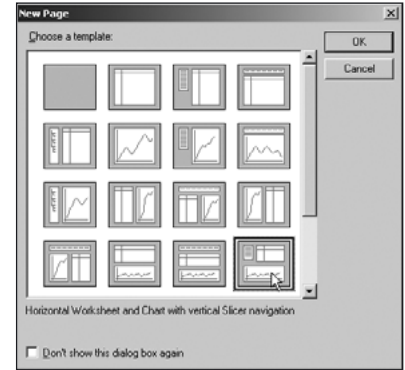
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## Page Templates

Many analytic reports look similar. They contain the same objects, with the same layout—but they display different data. Crystal Analysis provides templates for 21 common page styles, making it quick and easy to create analytical reports.

## Application Templates

Crystal Analysis has templates for common analysis requirements—sales analysis, key performance indicator (KPI) reporting, budget reporting, and web log analysis. Each application template steps the user through a simple wizard, which identifies a cube and then build a multi-page analytical report. This provides an even more rapid way for power users to create and deploy analytical reports.



## Parameterized Reports

Crystal Analysis reports can be parameterized to allow the following to be set before entering the report:

- The members displayed on the rows and columns
- The members selected for the paged dimensions
- The page the report opens to
- The cube the report is attached to

This feature is particularly powerful when reports are published to Crystal Enterprise. It enables web developers to design selection interfaces and use user information to provide a highly customized user experience. And it is possible to pass parameters to Crystal Analysis through a URL from a Crystal report. For example, a web developer may provide a web page displaying a map as an entry point to an analytic report. When the user selects an area on the map, they will be taken to the report which has the data corresponding to the region they chose, enabling them to investigate further.

## Actions

Invoking actions in Crystal Analysis enables users to quickly access data that resides inside or outside the OLAP cube. Most common is when users want to drill from OLAP cube aggregations to detail in the relational database. In this case Crystal Analysis can drill-through to Crystal Reports®, WebIntelligence, or any another application that you traditionally use for relational reporting. Beyond BI specific tools, actions can launch other applications, open web pages, send an email to a colleague, open files, or process HTML code.

Actions can be created in four places—dimension headings, members in a dimension, data cells, or analysis buttons. Actions are defined in the action manager, which can be invoked through the right click menu, and are resolved at runtime to create a context sensitive URL or HTML.

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# A Flexible and Powerful Tool

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Crystal Analysis is a robust tool that can be easily used within your current organization.

## Client Choices

Having designed easy-to-use analytical reports, the next step is to get them to the right people in the organization—the line-of-business managers who make the day-to-day decisions. Crystal Analysis is designed to allow easy distribution of analytical reports, both inside and outside the organization. Users can view reports using the Crystal Analysis desktop thick client, the DHTML zero client, or the ActiveX rich client. The zero-client option is the ideal method for web distribution and opens the possibility of sharing analytical reports with supplier, customers, and business partners.

## Thick-Client Deployment

A Windows based thick-client report design environment is used for creating analytical reports. The reports are saved as .CAR files on a local hard drive and shared between users who have the Crystal Analysis full client installed, or reports can be shared via the internet, an intranet, or extranet using Crystal Enterprise. Crystal Analysis reports can be locked and password protected during design time to prevent other users from making unwanted changes such as deleting pages.

## Deployment through Microsoft Excel

Crystal Analysis also provides an add-in for use with Excel. The add-in is ideal as an ad hoc slice and dice tool for the more experienced analysis user. Users can either choose to create a new connection to a data source or data can be exported from the thick client or rich client and remain connected, working within Excel. Data can also be viewed even if a connection to the data source is not available. Files are also saved as Excel files so they can be shared inside and outside the enterprise, or exported to other formats using the Excel native export function to create text files, presentations, or include figures easily in documents.

## Zero-Client Deployment

The Crystal Analysis zero client uses DHTML, so no applets, plug-ins, or controls need to be installed or downloaded. It offers the same level of interactivity and analysis as the thick client and the same intuitive user interface and dialogs to ensure that users do not require retraining.

The Crystal Analysis zero client supports Microsoft Internet Explorer and Netscape Navigator. It also supports a variety of web servers including Microsoft IIS, Netscape Enterprise Server, Apache, and other CGI-based servers. The web server runs on Windows today and will soon be available on Sun Solaris, HP-UX, IBM AIX, and Linux.

## Rich-Client Deployment

The Crystal Analysis rich client uses the same ActiveX technology as the thick-client designer. A plug-in must be installed on the local machine—requiring approximately 30MB download and 50MB of free disk space. This download occurs automatically from the web server when the plug-in is first required.

Unlike the zero client, the rich client communicates directly with the data source and Crystal Enterprise. This increases the speed that data can be received and processed, making it ideal for intranet deployment.

The rich-client is designed for use with Internet Explorer browsers 5.5 and above. It can be used with the same web servers as the zero client and the two can be used easily within the same deployment.

### Asymmetric Reporting

Crystal Analysis supports asymmetric reporting, which gives users greater flexibility over the appearance of reports by enabling them to control the appearance of innermost dimensions. For example, finance and accounting departments may want to hide irrelevant data such as budget and variance data for previous quarters or actual and variance data for future quarters.

### Changing Member Display

Users need to see information presented in reports in a way that is consistent with how information is normally referenced within their organization. For example, some companies may reference products by SKU numbers, while others may find it easier to use product names. Crystal Analysis gives users the flexibility to present members using their captions, names, or both.

Products	Sales : Sales	Cost : Cost	Margin : Margin
All Products : All Products	170,888,357.64	138,298,880.85	31,589,476.80
Bakery : D003	10,510,721.83	8,505,040.99	2,005,680.83
Cakes and Pies : C011	4,334,286.74	3,509,385.38	824,901.35
Loaves and Buns : C010	5,277,895.03	4,268,379.24	1,009,515.79
Other : C009	888,540.06	727,276.36	171,263.69
Frozen Goods : D001	5,371,773.20	4,725,072.66	646,700.54
Fruit and Vegetable : D006	33,436,399.40	26,261,723.40	7,174,676.02
Grocery : D004	76,376,769.52	63,676,754.16	12,700,015.30
Meat : D005	32,338,893.35	26,554,678.06	5,784,215.34
Wine and Spirits : D002	12,853,800.35	9,575,611.58	3,278,188.77

Version : Actual : 2 | Week : All Weeks : All Weeks | Year : All Years : All Years

# Powerful Analysis

Crystal Analysis has a wide range of features for creating rich analytical reports and allowing more sophisticated users to carry out further analysis.

## Advanced Navigation

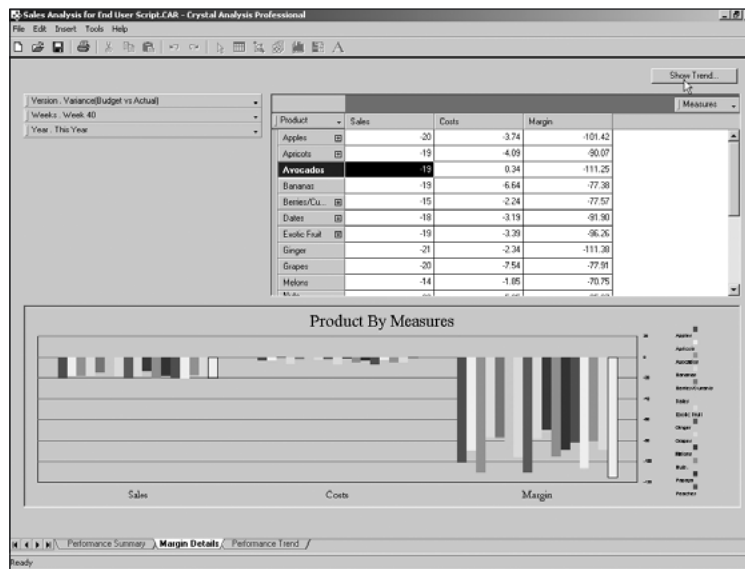
Using analysis buttons, analytical reports created within Crystal Analysis can guide users through the process of navigating and exploring OLAP data.

The following example shows a simple guided analysis application for exploring supermarket product performance. It takes the user through three simple analysis steps to diagnose the cause and significance of the problem.

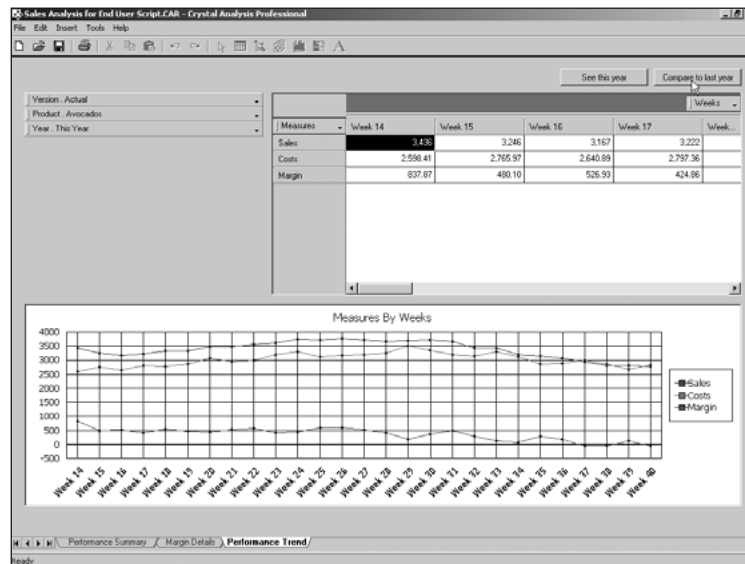
The first graphic highlights product groups with sales under budget—fruit has the poorest performance. The user highlights fruit and presses the analysis button marked Show details..., and goes to the second page.

	Actual	Budget	Variance(Budget vs Ac.)
All Products	222,424.24	314,502.40	-92,078.16
<b>Fruit</b>	2,453.95	32,482.52	-29,928.57
Frozen Food	9,273.32	11,211.69	-1,938.37
Bakery	30,883.12	32,439.77	-1,556.65
Grocery	132,697.77	134,009.55	-1,311.78
Vegetables	34,028.98	27,725.00	6,303.98
Meat	66,267.91	51,931.77	14,336.14
Wine and S.	35,541.09	24,587.54	10,953.55

The second graphic has drilled down on the chosen group and shows the variances as a worksheet and chart. The user can easily see that the costs are below budget—which is good—but sales are also below budget—which is bad. The user highlights avocados and presses the analysis button marked Show Trend which displays the third page.



The final graphic shows the trend for the chosen product—in this case it shows that sales of avocados have been dropping for some time. The Compare to Last Year button allows a quick check to see if this is a common seasonal pattern or not—in this case it is not.



## User Calculations

It is a common requirement that calculations be added to the report, creating values that are not stored in the OLAP cube. Crystal Analysis has a range of experts for common business calculations and allows advanced users to exploit the full MDX syntax of SQL Server Analysis Services.

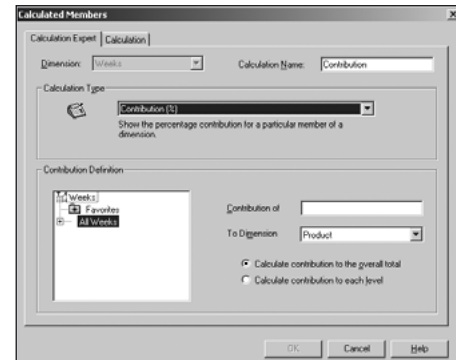
## Exception Highlighting

Exception Highlighting, also known as traffic lighting and conditional formatting, is a useful feature that allows report creators to highlight information based on predefined rules. The following sections will explore the challenges of exception highlighting and the innovative techniques used by Crystal Analysis to provide relevant highlighting of OLAP data.

## The Challenge of Exception Highlighting

Typically OLAP client tools will only allow users to add exception highlighting to color specific values, for example values less than 50,000 in red and values over 100,000 in green. The problem with this approach is that it does not account for different types of values that may coexist in the same cube. To illustrate, consider a sales report for a department store that shows products in the rows and measures in the columns. Sales in the audio visual department are higher than in the children's wear department. The ability to apply different exception highlighting is important because different products need different exception thresholds.

Measures may also require different exception thresholds. For example, margin will always be significantly less than sales and costs. Exception highlighting that does not account for these factors is meaningless.



Product	Sales	Costs	Margin
All Products	1,891,123	1,522,106.09	309,459.26
Bakery	158,355	128,300.43	30,054.12
Frozen Gro...	67,540	59,275.51	8,264.52
Fruit	155,245	152,877.83	2,450.00
Grocery	732,300	659,864.51	132,637.77
Meat	368,210	302,003.99	66,267.81
Vegetables	145,576	115,567.61	30,029.55
Wine and S...	139,817	104,273.28	35,543.88

Another challenge is that exception highlighting is misleading and invalid when a user drills down on a member. A value of \$450,000 may be an acceptable sales figure for the A/V product group dimension, but once a user drills down to see sales for TVs, VCRs, and DVD players, the exception highlighting is inaccurate.

Finally, this sort of exception highlighting does not answer the questions that users try to answer. It is more common for users to want to compare values, for example to find out which sales executives were under their target, or which products have sold less than in the same week for a previous year. Crystal Analysis addresses these highlighting challenges.

Product	Sales	Costs	Margin
All Products	1,631,123	1,522,168.28	309,426.26
Bakery	158,305	128,303.45	30,003.12
Frozen Goods	67,540	59,276.51	8,313.32
Fruit	155,245	152,017.55	2,453.90
Grocery	732,380	659,064.51	132,892.77
Meat	368,210	302,000.95	66,267.81
Vegetables	149,576	115,567.61	34,029.95
Wine and S...	139,017	104,273.28	35,803.89

### Color-Coding by Comparison

Crystal Analysis allows exceptions to be highlighted based on a comparison. Consider a worksheet displaying sales, costs, and margin numbers for one week. By using the by comparison to another dimension member option and choosing to compare to the budget figures, the product groups under budget are highlighted in red while those over budget are green.

Product	Week 37	Week 38	Week 39	Week 40	Week 41
All Products	1,636,960	1,828,115	1,828,932	1,828,932	1,828,123
Bakery	153,941	159,052	157,107	159,359	158,305
Frozen Goods	63,422	63,407	64,328	67,540	67,540
Fruit	155,969	161,911	159,288	155,245	155,245
Grocery	728,833	777,462	765,179	732,380	732,380
Meat	367,004	363,453	367,526	368,210	368,210
Vegetables	147,242	151,937	153,046	149,576	149,576
Wine and S...	146,881	143,008	143,008	139,017	139,017

This comparison is valid at all levels of the hierarchy and is unaffected by drill down. It is also valid for all measures.

### Color-Coding Using a Calculation

The second technique is to use a calculation to drive color coding. In this example, the worksheet is displaying the actual sales for several weeks. Using the Use result of a calculation option, product groups with rising sales are highlighted green and those with falling sales highlighted red. As in the previous example, the highlighting is valid wherever the user drills down and in any measure viewed.

This technique can be used to identify exceptions in many other advanced ways, including:

- Using the average of the displayed values
- Using the average across the siblings of a dimension member
- Bubbling up exceptions from the bottom of the hierarchy

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## Filtering

Filtering allows a page in the report to include or exclude certain values, making it easier to find important data. Using simple dialogs, Crystal Analysis can include or exclude:

- Top n (e.g. who are my top five sales executives this quarter?)
- Top n% (e.g. which sales executives make the top 10% of my sales?)
- Greater Than a given value
- Greater Than or Equal to a given value
- Less Than a given value
- Less Than or Equal to a given value
- Between two values
- Missing (NULL) values

Filters can be applied and modified when the report is designed and when the user is viewing the report.

## Sorting

Sorting is available on both the rows and the columns of the worksheet. Nested sorts are allowed and sorts can either sort with the hierarchy groupings or break the hierarchies. The former is useful for seeing which sales executive has the highest sales in a region, while the latter shows which sales executive has the highest sales across all regions.

Like filters, sorting can be specified when the report is designed, and by the user when viewing the report.

## Data Analysis

Crystal Analysis provides the ability to perform data analysis using simple statistical analysis. In one click, Crystal Analysis provides you with a range of summary statistics and can determine the best-fit line for any row or column of data. This enables users to see, at a glance, what the maximum, minimum, and average values are over a large number of cells, as well as a variety of other statistical measures.

A range of calculation experts were created for common analytic functionality including trend lines, moving averages, and linear regression. So users can easily see the overall trends in a series of data.

# Highly Scalable

An OLAP cube may have 5, 10, 20, or more dimensions. Some dimensions—such as time and measures—are small but others—such as customers and products—may have hundreds, thousands, or millions of members. When multiplied together, this equals many billions of potential data points in the cube. Dealing sensibly with this size of cube, and with the results a user may ask for, is a key challenge for any OLAP client tool. Crystal Analysis can address this need.

## OLAP Scalability Challenges

It is tempting to think that the size of an OLAP cube or dimension is not really a challenge—after all, a typical report may only display a few hundred numbers or a user may only want to see the top 10 selling products. This assumption is correct when OLAP reports are completely packaged, that is when they have been rigidly designed and the user can never carry out ad hoc analysis on them. Where ad hoc analysis is allowed, data volumes can rapidly become a challenge.

Consider the worksheet shown. It shows the top 10 selling products from a dimension with 150,000 separate products, based on Q1 budget figures. The worksheet itself contains a very small amount of data—10 products by four quarters by two versions (actual and budget), or 80 numbers.

	Quarter 1		Quarter 2		Quarter 3	
	Actual	Budget	Actual	Budget	Actual	Budget
Cherry Tomato	43,652	42,334	42,788	44,859	44,859	43,796
Bowlhead To.	43,958	42,309	42,829	44,834	44,834	43,619
Other Plums	43,862	42,261	42,631	44,785	44,785	43,575
English Plums	43,967	42,237	42,772	44,760	44,760	43,606
Other Peaches	43,846	42,213	42,561	44,733	44,733	43,527
Packham Pe.	43,356	42,188	42,529	44,707	44,707	43,625
Confidence P.	44,027	42,164	42,294	44,682	44,682	43,396
Carabelle	43,547	42,118	42,311	44,632	44,632	43,754
Pineapples	43,275	42,092	42,394	44,607	44,607	43,493
Pawson Fruit	43,744	42,068	42,506	44,579	44,579	43,427

This kind of result set is very straightforward for any grid control to handle. It is also the kind of query that OLAP tools are designed for and most servers will return this result set in a matter of seconds. Handling this as a packaged report does not represent a scalability challenge.

Now imagine the ad hoc analysis steps that the user would go through to achieve this result. These are described in the table below, along with the data volumes returned.

Description	Values Returned
1. Display the default worksheet view of product groups by measures	24
2. Pivot to display quarters in the columns	32
3. Pivot to display Actual and Budget nested within the quarters	64
4. Open member selector to display members	150,500
5. Select all base members from the product dimension	1.2 Million
6. Apply a top 10 filter to Q1, budget	80

Steps four and five, highlighted in red, present the scalability challenge—not for the OLAP server, but for the client tool. Imagine the time taken to load 150,500 values into a tree control, or 1.2 million numbers (plus headings) into the typical grid control. It would simply not be viable from a performance or client resource point of view—especially for a web browser.

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## **Finding the Data**

Often the problems encountered with large data sets can be due to the difficulty of finding the data you want. Crystal Analysis provides productivity features that speed your analysis. By hiding unnecessary dimensions, the data instantly becomes clearer. Crystal Analysis allows you to remove dimensions from view without needing to edit the underlying OLAP cube.

Large and deep dimensions can be hard to navigate. The Crystal Analysis member searching functionality allows users to pinpoint the members they want based on the name, the level, or the attributes. Users can create complex search expressions by simply searching within the results. A single click loads the results of your search into the report.

## **Crystal Analysis and Scalability**

Crystal Analysis is designed to deal easily with prepackaged OLAP reports and to scale to the extreme demands of ad hoc analysis. Crystal Analysis makes the most of the scalability of SQL Server Analysis Services, expressing user queries in MDX and using the distributed caching capabilities of the pivot table service (PTS).

Each control buffers just enough information for the current display. This means that tree controls and grids are rarely displaying more than a few tens of members and data values. Even if users inadvertently request large result sets, Crystal Analysis governs the amount of data retrieved, which optimizes the web client's performance.

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## Support for OLAP Server Functionality

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Multi-dimensional analysis, by its very nature, is an interactive process that demands a fast and robust real-time connection to data. Most enterprise business intelligence (BI) systems provide a broad range of technologies and processes for optimizing real-time access to data. Applications that can leverage these built-in capabilities can deliver maximum productivity and performance to users.

Crystal Analysis is designed to fully exploit Microsoft SQL Server Analysis Services. The product delivers tight integration with Microsoft's Pivot Table Services and OLE DB for OLAP interface, pushing as much processing as possible down to the server using MDX, providing fast end user access to OLAP data. Our support for SQL Server Analysis Services qualifies Business Objects as a Microsoft Data Warehousing Alliance Partner. Crystal Analysis also supports SAP BW, Hyperion Essbase, IBM OLAP DB2, and Crystal Holos.

### Cross-Platform Support

Crystal Analysis can access OLAP servers running on Windows, Sun Solaris, and IBM AIX and will soon also support HP-UX and Red Hat Linux.

### Crystal Enterprise Architecture

Crystal Analysis's zero client is delivered using Crystal Enterprise, a globally scalable, web-based information delivery infrastructure. Crystal Enterprise offers a customizable, multi-tier architecture for the secure delivery of reports to end users. It enables seamless integration of analytical and reporting technologies including Crystal Analysis and Crystal Reports. The major components of Crystal Enterprise are shown below.

#### Central Management Server

The central management server (CMS) is responsible for user authentication and security of published reports. It is possible to cluster multiple CMSs as an aid to fault tolerance and scalability.

Analytical reports can be saved directly to an CMS-managed folder using the save dialog in Crystal Analysis. An extra file storage option allows users to choose which folder reports will appear in.

If there are many reports to publish, such as when a user is migrating from a small file sharing solution to a full-blown web deployment, a wizard is provided for publishing one or more reports in one step.

Once a report is published to Crystal Enterprise, a web-based management console allows administrators to assign rights to users, groups, folders, and objects, controlling which reports are accessible when a user logs in to Crystal Enterprise.

#### File Repository Server

The file repository server (FRS) is responsible for securely storing the files that have been published to Crystal Enterprise.

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## **Web Component Server**

The web component server (WCS) enables zero-client and rich-client access to Crystal Enterprise. When a user clicks on a hyperlink to an analytical report, the .CAR file is retrieved from the FRS and passed to the WCS. The WCS then loads the .CAR file and creates all of the required objects—worksheets, charts etc.

If the zero client is being used, the WCS will open a connection to the data server. It will generate a DHTML user interface that is passed through the web server to the user's browser. As the user navigates around the application, requests are sent back to the WCS, which generates an updated web page.

If the rich client is being deployed, the WCS will provide the .CAR file to the client which will then connect using a direct connection to the data server. It is possible to cluster multiple WCS as an aid to fault tolerance and scalability.

## **Intranets, Extranets, and Portals**

Crystal Enterprise is fully customizable, allowing it to be integrated into any corporate portal. Several samples are included with the product that can be used if there is no portal standard. Alternatively they can be used as worked examples of portal integration as the source code is included.

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## Built on an Extensible Platform

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The analytical report comprises a series of visual objects—worksheets, charts, etc.—and non-visual object-data connections. The data connections provide an abstract layer onto any OLAP data source and an OLAP data driver is plugged in underneath.

### **XML File Format**

The Crystal Analysis .CAR file is an XML file that fully describes the analytical report.

Analytical reports running in the WCS create XML outputs that describe the data to be formatted for the report. At present, this is converted into DHTML by XSLT style sheets on the WCS. As XML capabilities mature in browsers, it will be possible to pass the style sheets to the client and send down just the XML stream for formatting with a positive impact on the bandwidth required.



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