

The relative strength index has become one of the most popular and widely cited technical indicators. However, using it in time frames for which it wasn't designed requires customization of the inputs. With a few modifications, we can create an adaptive RSI that is more flexible.

Expanding the usefulness of RSI

BY DAVID SEPIASHVILI

Developed by J. W. Wilder in 1978, the relative strength index (RSI) has become one of the prevalent technical tools. This useful momentum oscillator has gained general recognition and found its way to all financial markets. When Wilder introduced the RSI, he recommended using 14 days for averaging upward and downward price changes. He intended the period to be equal to half the dominant cycle — namely the lunar 28-day cycle. He also suggested users consider levels of 70% or more as overbought and 30% or less as oversold.

However, in recent years, analysts are calculating the RSI for periods ranging between five and 25 days while using, for the most part, the originally suggested overbought and oversold levels. But at different look back periods, different overbought and oversold levels perform better. This limitation in the indicator's application is dictated by a variable attenuation factor of financial time series. The

higher the averaging period, the higher the accumulated losses are that result from the attenuation factor. This gives insight into why the best performing overbought/oversold range is narrower when the averaging peri-

ods are above 14, and widens with the periods below 14.

Here, we'll extend the application area of the classic RSI so that it could be applied to multiple market conditions and used with the same over-

CHANGING DIRECTION

A divergence vs. the prevailing price trend is the most important information provided by the RSI. Here, we can see how a midterm WRSI indicates bullish and bearish divergences in the price movement of Nortel Corp.



Source: Allcom, Inc.

bought and oversold levels not only in short-term tasks, but also in very short, intermediate and long-term analysis, as well as in multi-frame studies.

To address the problem of expanding the application area of the RSI we have developed the Wide-range Relative Strength Index (WRSI). The fundamental property of the WRSI is that it takes into account the attenuation factor compensating for variations in the RSI bandwidth for averaging periods other than 14. The WRSI is a simple way to measure momentum changes of market prices over any time frame.

The attenuation factor depends on the amount of days used in the calculation, on volatility, and upper and lower thresholds that mark the extremities of the RSI. Its calculation is based theoretically on Dow Theory principals, Elliott wave theory and retracement theory, combining the best of these approaches to provide an objective basis for good performance of the indicator. "Calculating the WRSI" (right) includes the formulae that resulted from this study.

INTERPRETATION OF WRSI

The RSI is a momentum indicator, designed to measure a security's strength or weakness relative to itself over a given period. The WRSI simplifies this application over time frames.

The characteristic feature of the WRSI is that it allows detection of momentum changes not only in short-term cycles, but also in midterm and long-term cycles. It shows security's strength relative to itself without any lagging not only for $n = 14$, as in its classic form, but for any averaging period, including intermediate and long term values.

Such an expansion naturally results in certain peculiarities. Estimating a security's strength over longer periods, the WRSI is less sensitive and less corrupted by noise than the classic RSI. But this filtering does not entail any lagging. Being less volatile, the

Calculating the WRSI

The basic formula for the WRSI is:

$$WRSI = \left(\frac{(k+1) * U(n) - (k-1) * D(n)}{2\{U(n) + D(n)\}} \right) * 100$$

Where:

$U(n)$ = n-point Moving average of (Price - Previous Price) positive values;

$D(n)$ = absolute value of n-point Moving average of (Price - Previous Price) negative values; k is an attenuation factor.

The WRSI equals the classic RSI in one particular case when $n = 14$, $k = 1$:

$$WRSI(n = 14, k = 1) = \left(\frac{U(14)}{U(14) + D(14)} \right) * 100$$

$$WRSI(n = 14, k = 1) = \left(\frac{RS}{RS + 1} \right) * 100$$

$$WRSI(n = 14, k = 1) = \left(1 - \frac{1}{RS + 1} \right) * 100$$

$$WRSI(n = 14, k = 1) = RSI$$

Where:

$RS = U(14)/D(14)$ = Relative Strength.

For estimation of the attenuation factor k the following formulas, covering all conventional time terms, can be used:

$$k = 0.6 + 0.03 * n \quad (\text{for } n = 5 \text{ to } 20)$$

$$k = 0.4 * \ln(n) \quad (\text{for } n = 20 \text{ to } 200)$$

The formulas give estimates of k . The absolute error of the estimates is limited to 5% and is within the accuracy of the technical analysis. The net results of the calculation of k for some useful values of averaging period n (days, weeks, months) are given below:

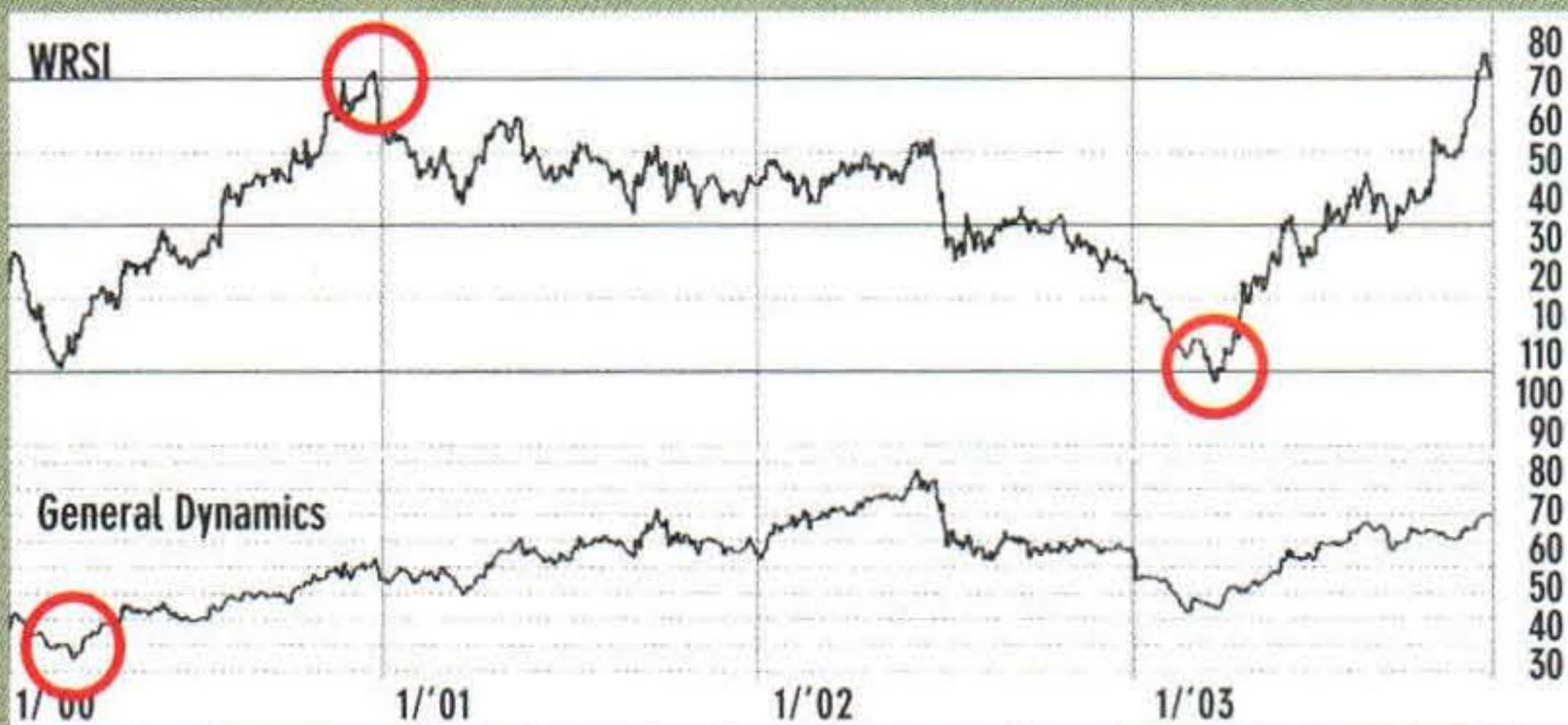
n	5	8	10	12	14	20	30
k	0.75	0.84	0.9	0.96	1.02	1.2	1.36
n	40	50	60	70	100	150	200
k	1.48	1.56	1.64	1.70	1.84	2.0	2.12

The number of points n used in calculation of the WRSI should fit the market cycle you are watching. For example, if you intend to detect momentum for a 20-day trough-to-trough or peak-to-peak ascending or descending cycle, the length of an appropriate moving average in calculation would be $n = 20 * 0.7 = 14$; for a 70-day cycle the period of the WRSI would be $n = 70 * 0.7 = 50$, etc.

If you intend to detect momentum for a 70-day cycle, the length of an appropriate moving average used for calculation would be $n = 70 * 0.5 = 35$. When use 0.7 and when use 0.5 for a cycle length? The ratio of average lengths of rise and decline in ascending cycles and the ratio of average lengths of decline and rise in descending cycles is about 2.5, so $2.5/(2.5 + 1) = 0.7$, while the lengths of rise and decline semi-cycles in ranging markets are approximately the same, and the ratio, correspondingly, is equal to $1/(1 + 1) = 0.5$.

LONG-TERM LOOK

In this chart we can see how well the WRSI of General Dynamics shows 70-30 overbought/oversold levels even with a long period (200-day) used in its calculation.



Source: Alticom, Inc.

CROSSING OVER

A long-term WRSI calculated on a weekly basis presents directional divergence in a more smoothed manner. The extended divergence, sloping down overbought readings and central line crossovers combine to signal an upcoming reversal in the uptrend in American Express.



Source: Alticom, Inc.

UTILITY VEHICLE

A very long-term WRSI of the Dow Jones Utilities Average calculated on a monthly basis provides a big picture view of this market sector for the last 53 years.



Source: Alticom, Inc.

midterm and long-term WRSI preserves the properties of a momentum indicator. You can see the momentum of the price trend rather than the velocity of its short-term day-to-day fluctuations.

The interpretation of the WRSI is, with minor exceptions, the same as of the classic RSI.

A favorite method of interpreting momentum indicators is looking for a divergence opposite to the prevailing price trend. If a price is in an up-trend and continually reaching new highs, but a momentum indicator is moving lower, a trend reversal could be in the offing. "Changing direction" (page 34) shows bullish and bearish directional divergences in the price movement of Nortel Networks Corp. and its 70-day WRSI. A bullish divergence occurred during July through October 2002 when prices were falling while the WRSI was rising. Then the prices subsequently corrected and trended higher. During the rally in 2003, the price made new highs while the WRSI failed to surpass its previous highs. The divergence signaled that close attention should be paid to the price action for reason of a possible reversal of the trend.

Bullish and bearish interpretations can be found by looking for centerline crossovers and extreme readings of the WRSI, which manifest overbought/oversold conditions. In "Long-term look" (left), the 200-day WRSI of General Dynamics, sloping upward and downward relative to upper and lower boundaries of the indicator, manifests not only overbought/oversold conditions but signals in advance the change in the trend by topping out before the underlying price.

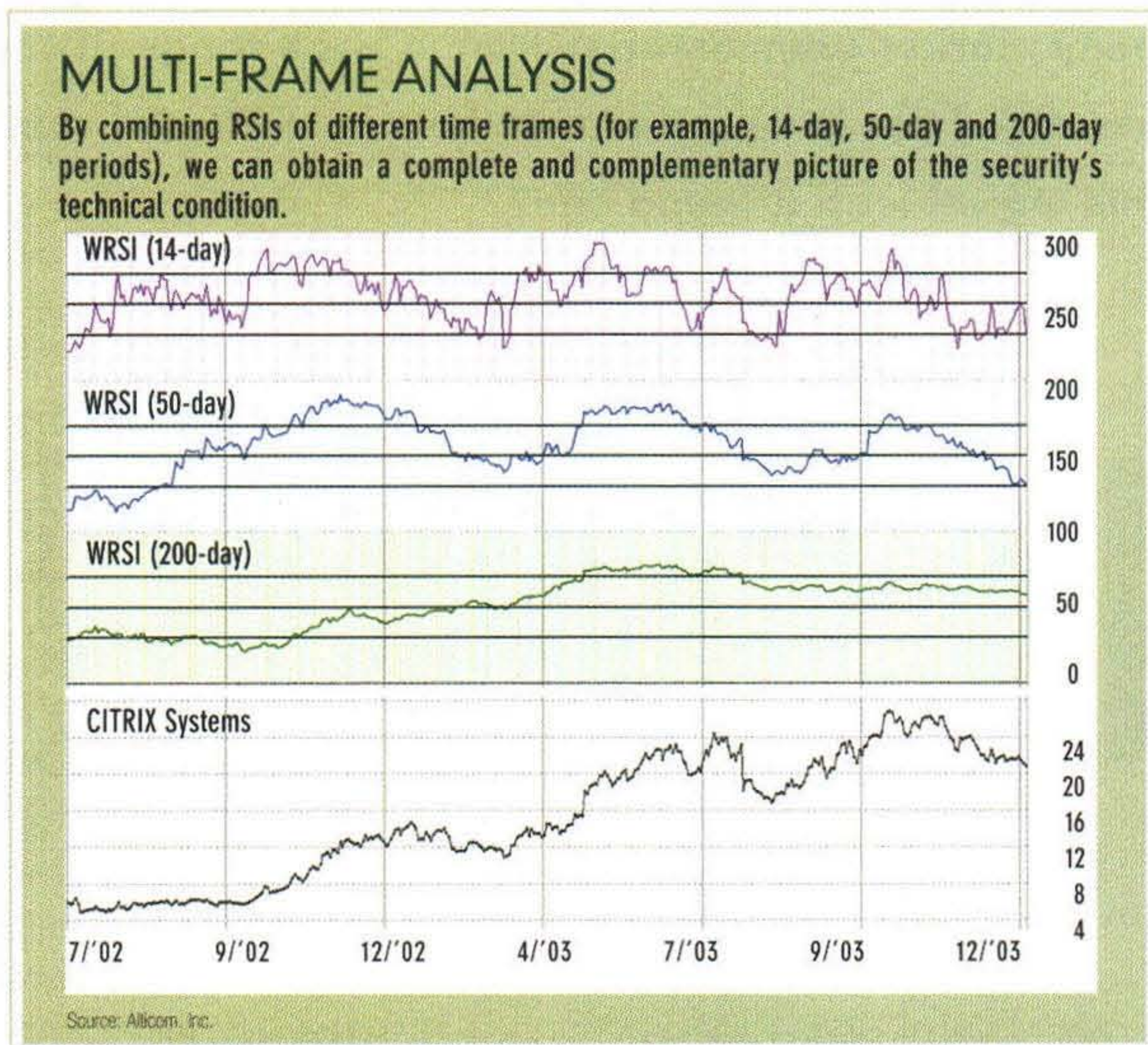
As the functionality of the short-term indicator is widely covered in numerous sources, we place more emphasis in the examples on midterm and long-term applications. Note that a transfer into the traditional domain of lagging indicators can be achieved not only by extending the number of

days in the WRSI calculation, but also by converting any WRSI calculated on a daily basis into weekly or monthly WRSIs. Such a conversion gives a more smoothed picture in comparison to the WRSI calculated on a daily basis. In "Crossing over" (left), a price chart of American Express Co. and its 40-week WRSI are presented. It is another illustration of typical long-term directional divergence in price uptrend and its WRSI. The uptrend lasting almost six years is not supported here by the sloping downward WRSI and relative to 70 and 50 level readings.

As shown in "Utility vehicle" (left), the WRSI can be a powerful support tool for extremely long-term investment. The 30-month WRSI of the Dow Jones Utility Average (DJUA) accurately tracks trending periods the market has exhibited during the last 53 years. You can also see that in the macro-context a blow-off we have experienced recently is apparently a normal behavior of the stock market's cyclical nature.

As can be seen from the examples, the WRSI as a momentum indicator usually turns ahead of price and can mostly be used as a divergence indicator. The modulation of peaks or troughs in extended uptrends or downtrends assumes a new importance characteristic for the midterm and long-term WRSI. In longer time spans, the WRSI becomes most useful in trending periods, as its readings do not distort overbought, oversold and divergence signals.

It's much more reliable to get trading support signals from relative strength indicators of different time frames. Multi-frame analysis attempts to analyze short, intermediate- and long-term cycles based on their individual WRSIs. The approach will let the trader see the big picture and not just an isolated picture, which can be misleading if it is not adequate to the length of the price movement's actual cycles. This can be useful not only as a strate-



gy guide, but also for finding comfortable trading or investing ranges, which will unfold in the charts.

One combination that has a good track record in timing stock market time-series is a set of three WRSIs with 14-, 50- and 200-day averaging periods. "Multi-frame analysis" (above) illustrates these indicators. The 50-day WRSI matches peaks and troughs of the price, but if each new peak of the price is higher than previous ones, the successive peaks of the WRSI are lower than the previous ones signaling a breakout. The readings are confirmed by the 200-day WRSI. After July 2003 it descends, showing that a price uptrend is losing momentum. This gives a cautionary signal of price possibly reversing into a downtrend or congestion phase. The 14-day WRSI, provides a shorter view, gives more detailed information about the process, though oscillating back and forth so frequently it has little to offer in trend detection and upcoming reversal recognition by itself. However, the three time frames combined provide a com-

plete and complementary picture of the security's technical condition.

The WRSI represents security's price cyclical, wave-like motion in a banded oscillator format. It is designed to preserve preset values of its extremities — overbought/oversold levels — without regard to averaging period in its calculation. The indicator widens when the amount of days used in the calculation is above 14, and narrows when the period used for calculation is below 14. The WRSI remains a momentum indicator for cycles longer than a 14-days, expanding the functionality of a momentum indicator to midterm, long and very long terms, squeezing its way into the traditional domain of trend-following indicators. This distinctive feature allows the indicator to be applied to multi-frame analysis. **FM**

David Sepiashvili is a doctorate candidate in signal processing at Carnegie Mellon University in Pittsburgh. Financial time series analysis is one of the applications of his scientific efforts. He is president of Alticom Inc., which has developed a number of solutions for stock market technical analysis (www.alticom.com). Reach him at: das@alticom.com.