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The Radio Frequency Systems Bulletin

The Clear Choice™

Telstra's Next G™: pretty in PIM

- RFS proves AISGv2.0-ready
- AWS: Getting the mix just right
- Communicating from the coalface
- The waking of India's wireless giant

Radio Frequency Systems

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On the cover: Built in a record 10 months, Telstra's Next G™ network is the world's largest UMTS network geographically, and one of the world's first UMTS services to operate in the 850MHz band. The nationwide network features an RFS-tailored transmission line connector that exhibits unrivalled passive intermodulation (PIM) performance under a range of dynamic situations.

RFS proves AISGv2.0-ready
RFS unveils a new end-to-end tower-top solution set that is compliant with the latest revision of the open communications standard of the Antenna Interface Standards Group (AISG).

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AWS: Getting the mix just right
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Communicating from the coalface
As US mine safety requirements are intensified, RFS's RADIAFLEX radiating cable passes the test to deliver a unique wireless in-tunnel solution that is finding widespread application in US coal mines.

The waking of India's wireless giant
As India's wireless growth outpaces the rest of the world, RFS is on-hand, providing solutions tailored to the region's wireless landscape.

Perspective and the price of spectrum

In a future-focused industry such as ours, sometimes it pays to put recent changes in perspective. It may be time we examined the year just passed within the context of the decade gone by.

Both pundits and players would doubtless agree that 2006 was a year 'headlined' by the US Federal Communications Commission (FCC) Advanced Wireless Services (AWS) spectrum auction. Although FCC Auction 66 successfully concluded in September, it was only after months of delay, heated debate and boiling controversy--mostly centered around FCC attempts to create a 'level playing field' for potential bidders.

By its close, however, the auction raised US$13.8 billion in what was billed as the US's "largest spectrum auction". A total of 104 bidders bought 1,087 licenses—and, while tier one carrier, T-Mobile, was easily the biggest spender (US$4.2 billion), consortiums of carriers and cable companies also bought up big. Notably, about half the bidders qualified as small businesses.

It was subscribers, however, who were declared the true auction winners—destined to receive better quality coverage with fewer dead spots, and the enticing prospect of full third-generation (3G) capabilities, including mobile video, wireless Internet, and a clutch of equally covetable wireless data services.

The AWS auction provides interesting insight into the maturity that the wireless market—both in the US and globally—has achieved over the past years. From a global perspective, the AWS auction's dollars-per-megahertz-per-head of population ($/MHz/POP) average (and peak) prices are much the same as that achieved at the US 1994/95 PCS auctions. Contrast this with the 2000 UK and German auctions, and US 2001 PCS auctions, which each realized average $/MHz/POP figures that were an order of magnitude higher than those of the 2006 AWS auction! (Remember as well that the 2001 PCS 1900MHz-band auction also raised more money than Auction 66, generating US$17 billion for treasury coffers).

What can be drawn from these comparisons, then, is that the wireless industry has managed a lot of 'growing up' in the space of six years.After that peak in 2000/2001, we have overcome the damaging model with its string of consequences, notably among Western Europe operators (remember the British and German auctions in 2000).

Auction 66 was not conducted amid a feeding frenzy. Rather, it introduced few new entrants to the market, exemplifying, instead, a more stable market, with a firm grip on a rationalized and strategic business plan.

Stéphane Klajzyngier
Radio Frequency Systems President

Underpinning these strategies, and the industry's growth, is a mounting confidence in the viability of evolving technologies and applications. Mobile TV's potential is proven; WiMAX and High-Speed Packet Access (HSPA) are no longer vaguely understood acronyms. Carriers are seeking to deliver the 'quadruple play' so attractive to subscribers. Bundling telephone, television, high-speed Internet and wireless service into an irresistible package is bound to stimulate economic growth.

However, while the business models are more consolidated, and spectrum pricing less volatile, there remain many challenges. Notably, these are in the area of network deployment and management—particularly in the RF realm. New technologies and applications—often in new bands and complex band overlays—present entirely new RF challenges.

These RF challenges are brought into sharp focus when you consider three important spectrum allocations that are 'on the books' for the near future.

First, the German telecoms regulator (the Bundesnetzagentur) is said to be planning a new round of 3G auctions for 2008—the first since 2000 and the first to offer 2.6GHz spectrum for 3G deployment. The second allocation is China's Ministry of Information Industries' long-awaited spectrum allocation for its all-new 3G platform, Time Division-Synchronous Code Division Multiple Access (TD-SCDMA). Thirdly, in April, the Russian Federal Communications agency is expected to announce the successful tenders for its 2.1GHz allocation from a field of 11 bidders.

Although these allocations are set in a 2007 spectrum market that is far more predictable (compared with the volatility of 2000/2001), other issues are less defined. Both 3G deployments will generate a fresh round of network RF challenges.

What we can predict, with certainty, is that RFS will be there—ahead of the game—to provide the most effective and cost-efficient RF solutions in these 3G deployments. You can count on us to maintain our perspective.

Stéphane Klajzyngier

WiMAX adaptive antenna solution

The latest in the series of Radio Frequency Systems' 'WiMAX-ready' adaptive antenna systems is the new W4AxxW wideband antenna series—an innovative solution set that streamlines and simplifies global worldwide interoperability for microwave access (WiMAX) deployment strategies.

Comprising just two models—the W4A25W-90ANV (2.3 to 2.7GHz) and the W4A35W-90ANV (3.3 to 3.8GHz)—the new wideband antenna series supports the widest range of sub-bands currently allocated for WiMAX applications across Europe, the Americas and the Asia-Pacific region. Achieving global reach with just two models, the new RFS W4AxxW dramatically cuts inventory requirements and costs, and improves deployment efficiencies.

"WiMAX technology promises a new era in broadband wireless connectivity across fixed, nomadic and mobile platforms," said RFS Area Product Manager, Rémi Deniel. "It also poses new challenges on the network management and RF fronts—most particularly as subscriber demand increases and greater network capacity is required. The new wideband W4AxxW series WiMAX adaptive antenna system specifically addresses these challenges, by providing the precision beam-pattern shaping required to dynamically support the evolving needs of the WiMAX network."

At the heart of each W4AxxW series adaptive antenna system is a four-element antenna array. Flexible beam-pattern tailoring is achieved by applying phase and amplitude modulation to each element. As a result, the shape of the beam-pattern can be modified in response to changing subscriber traffic and interference sources, or as part of a longer-term strategy to ensure optimal data throughput, spectrum use or network capacity.

The W4AxxW series antenna system is part of RFS's broad and growing IEEE 802.16 WiMAX-compliant solution set—a set which will include: antennas, RF conditioning solutions, and 'WiMAX-ready' in-building solutions.

New L-band antenna—tailored for mobile TV

The world's first purpose-built for mobile TV L-band panel antenna has been unveiled by Radio Frequency Systems. Specially designed to meet the exacting requirements of digital video broadcasting-handheld (DVB-H) and digital audio broadcasting (DAB) applications, the new RFS L-band antenna offers unmatched electrical performance, and simplifies mobile TV and digital radio network rollout.

The new RFS L-band antenna is vertically polarized, and supports applications across the entire broadcast L-Band—1452 to 1675MHz. It boasts first-class vertical standing wave ratio (VSWR) performance, advanced null fill characteristics, and high power-handling capabilities.

"The RFS L-band antenna is the only antenna on the market specifically designed for broadcast L-band applications," said RFS Principal Engineer Antenna Development, Charlie Williams. "Modified base station antennas are often employed in broadcast applications. This kind of design short-cut can result in poor broadcast signal quality and interference."

According to Williams, the new RFS L-band antenna produces VSWR values less than 1.1 across the bandwidth for DAB (1452 to 1492MHz). Adapted base station antennas typically display VSWR values of approximately 1.3, which is undesirable in applications such as mobile TV and digital radio.

"The new RFS L-band antenna provides mobile TV networks with robust and uniform broadcast signals, sculpted to the coverage area," Williams said. "Its null fill functionality and side-lobe suppression help minimize reflections and interference."

RFS's L-band antenna also features a high power-handling capability (up to 750 watts), making it ideal for both built-up urban environments, and remote areas requiring extensive coverage. It is available in 65- or 90-degree horizontal beam width versions with multiple mounting arrangements.

CELLFLEX Lite— now in 1-5/8-inch

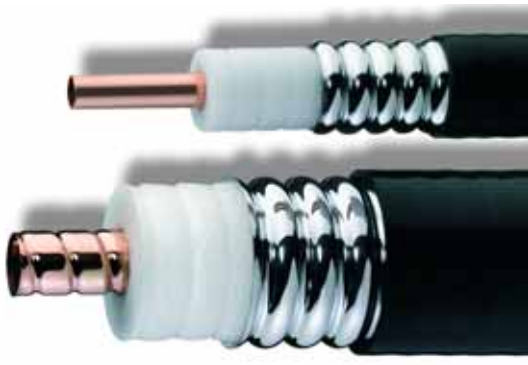
Radio Frequency Systems now offers the world's first corrugated aluminum transmission line—CELLFLEX Lite—in 1-5/8-inch diameter size. Specifically designed to accommodate higher-power wireless applications, the new 1-5/8-inch CELLFLEX Lite cable offers a lightweight solution to assist the rapid roll-out of wireless network infrastructure.

Complementing RFS's existing copper transmission lines, CELLFLEX Lite is a foam-dielectric corrugated coaxial cable with an aluminum outer conductor and a copper inner. Offering an alternative price point and performance combination, CELLFLEX Lite's robust construction and advanced electrical performance herald the next generation in RF transmission development.

Weighing only 950 grams/meter (0.64 lb/ft), the 1-5/8-inch CELLFLEX Lite cable is easy to transport, handle and install. "It is the lightest RF transmission cable on the market today. Its lightweight design, coupled with its single and multiple bending-radius capabilities, allow fast installation and make it ideal for congested tower-top applications," said Area Product Manager for Transmission Lines, Matt Gauvin.

The new 1-5/8-inch diameter CELLFLEX Lite cable complements the popular 7/8-inch diameter version launched in mid-2006. Both deliver world-class attenuation, return-loss and intermodulation performance. "The electrical performance of CELLFLEX Lite is superior to some copper transmission cables offered by our competitors," Gauvin said.

Compatible with RFS's existing range of accessories and tools, CELLFLEX Lite utilizes the 'RAPID FIT Lite' connector series, based on RFS's popular RAPID FIT range. The CELLFLEX Lite and RAPID FIT Lite connector pair offers return loss and intermodulation performance equal to that of CELLFLEX 'A'; the cable is available in UV-resistant polyethylene (JL) or flame-retardant jackets (JFNL).



CELLFLEX Lite transmission line is now available in 1-5/8-inch (bottom) and 7/8-inch.

Gain advantage with RFS triple-band VET antenna

Radio Frequency Systems' new triple-band variable electrical tilt (VET) base station antenna series provides performance where it really counts in third-generation (3G) network roll-outs—high-band gain and premium tilt control. Available in three lengths (1.6m/5.25ft, 2.1m/7ft and 2.6m/8.5ft), the new triple-band antenna exhibits an unrivalled 17.5dBi nominal high-band gain. The antenna comprises two broadband high-band arrays (1710 to 2170MHz) and one low-band array (880 to 960MHz), all in a compact slim-line package.

Courtesy of the antenna's unique and world-patented 'side-by-side' multi-band architecture, the 17.5dBi high-band gain is consistent across both the high bands, and across all three models. High-band gain is a vital factor in 3G roll-outs: it helps supplement indoor/in-building coverage in urban environments, and achieve larger cell sizes for coverage in rural applications.

For premium optimization and network management, the new triple-band antenna provides independent VET of 2 to 10 degrees across all three bands. Control across this tilt range is realized via Antenna Interface Standards Group (AISG)-compliant control technology.

Conventional multi-band antennas typically use a 'stacked' architecture, which not only causes a gain differential between both the high bands, but also physically limits the gain that can be achieved in all three bands. "The RFS 'side-by-side' architecture overcomes these problems, and ensures that both high bands in any one antenna are electromagnetically equivalent," said RFS Area Product Manager, Rémi Deniel. "More importantly, it allows us to achieve the highest levels of high-band gain in the tri-band sector."

The compact RFS tri-band antenna offers excellent upper side lobe suppression, exhibiting first upper side-lobe levels of better than 18dB on the low band and 15dB on both high bands.

RFS proves AISGv2.0-ready

Radio Frequency Systems has unveiled a new end-to-end solution set that allows remote control and monitoring of tower-top RF components. Fully compliant with the latest revision of the open communications standard of the Antenna Interface Standards Group (AISG), the new RFS suite empowers carriers to cost-effectively optimize their networks in real-time.

The new RFS AISG version 2.0-compliant product suite frees the end-user from the inherent restrictions associated with proprietary control and monitoring systems, ensuring fast-track network retrofits and greenfield deployments. The solution makes it possible for carriers to control and monitor tower-top components either locally (from the tower base), or remotely from the network's operations and maintenance center (OMC).

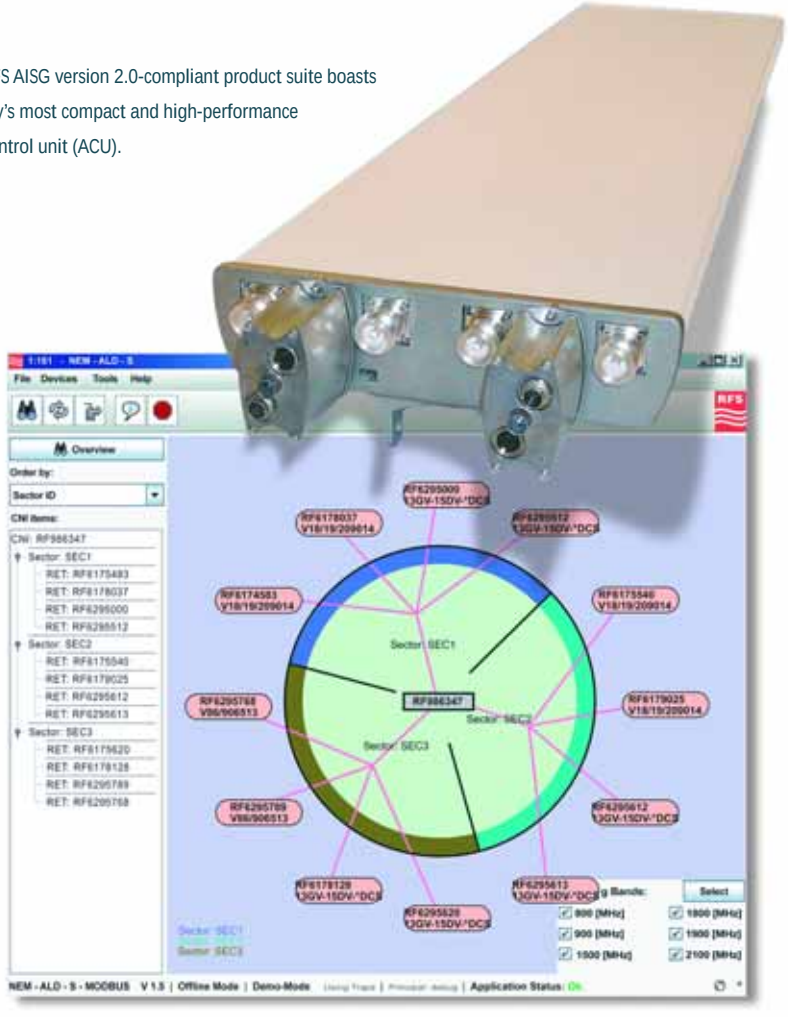
A true end-to-end third-generation (3G) solution, RFS's new AISG version 2.0-compliant product suite comprises all key antenna line elements—the control network interface (CNI), a selection of tower-mount amplifiers (TMA), an antenna control unit (ACU) and a modem bias-tee. "The day-to-day, hour-to-hour—and even minute-to-minute—network RF monitoring and optimization that the RFS AISGv2.0-compliant solution provides is essential in today's competitive wireless world," said David Kiesling, RFS Global Product Manager Wireless Infrastructure Solutions. "This is particularly crucial in advanced broadband wireless data solutions, along with mature 2G networks."

The new RFS AISG version 2.0-compliant solution set includes RFS's innovative Network Element Manager (NEM) software—considered to be one of the most intuitive and user-friendly software interfaces for an AISG version 2.0 solution set.

The new RFS NEM software has been specifically designed for ease-of-use and ensures fast-track network installation, commissioning and troubleshooting. Step-by-step instruction provides uncomplicated access to a vast library of antenna line device (ALD) diagnostics and settings, such as antenna tilt, azimuth adjustment and real-time ALD system diagnostics. As a result, abnormalities such as loose connections, power loss and antenna over-travel, can be detected and corrected before they impact on network QoS.

The suite also boasts the industry's most compact and high-performance AISG version 2.0-compliant ACU. Its lightweight construction (only 470g/1lb) helps reduce tower loading, while its small footprint and sleek design minimizes environmental impact. Performance-wise, it provides a continuous torque of 0.15Nm and boasts an angular resolution of better than 0.2 degrees. The new ACU also features a non-volatile on-board memory, ensuring that all programming data is retained if the CNI has to be replaced or DC power is disconnected. The new RFS 19-inch rack format CNI-P incorporates a power distribution unit (PDU), which supports up to six TMAs and 12 ACUs across three sectors. Individual ACU and TMA units are linked in a 'daisy-chain' configuration, with the CNI's networks capable of supporting up to a total of 18 ALDs over a maximum cabling length of 100 meters (330 feet). The CNI itself provides three separate RS485 field output ports (one per antenna sector). CNI backhaul connectivity is achieved via either point-of-protocol (PPP), simple network management protocol (SNMP) or Dynamic Host Configuration Protocol (DHCP), with either fixed or dynamic IP address management.

The new RFS AISG version 2.0-compliant product suite boasts the industry's most compact and high-performance antenna control unit (ACU).



Intuitive and user-friendly, RFS's innovative Network Element Manager (NEM) software provides uncomplicated access to a vast library of diagnostics and settings.

Telstra's Next G™: pretty in PIM

Faced with cramming a UMTS 850MHz network into the spectrum between CDMA and GSM, Australia's Telstra turned to RFS for a tailored coaxial connector to dramatically improve PIM performance.

What do you get when you co-locate CDMA 850MHz, GSM 900MHz and UMTS 850MHz services? The answer, according to Australian wireless carrier, Telstra, is a very big challenge. For the engineering department, that is. The impact of these spectral neighbors on each other—if not treated appropriately—can lead to severe interference and blocking of highly sensitive receivers, resulting in dropped calls and reduced network performance.

Nevertheless, Telstra has successfully overcome this challenge, and launched its national 850MHz Next G™ universal mobile telecommunications system (UMTS) mobile broadband network on 6 October 2006. Built in a record 10 months, Telstra's Next G™ network is the world's largest UMTS network geographically, delivering average network download speeds of 550Kbps to 1.5Mbps, courtesy of high-speed downlink packet access (HSDPA) technology.

The Next G™ network is also one of the world's first UMTS services to operate in the 850MHz band. It is ultimately expected to replace Telstra's existing code division multiple access (CDMA) service. For the moment, however, it is coexisting with CDMA, adjacent to Telstra's 900MHz global system for mobile communications (GSM) service. According to Garry Johnston, Telstra's National RF Systems Engineering Manager, Mobility Engineering, this globally unique 'cocktail' of services has made co-locating the base stations a huge challenge. Not only do the transmit and receive bands of the three services occupy similar spectrum, leading to the potential for blocking issues, but third-order passive intermodulation (PIM) products posed a problem as well.

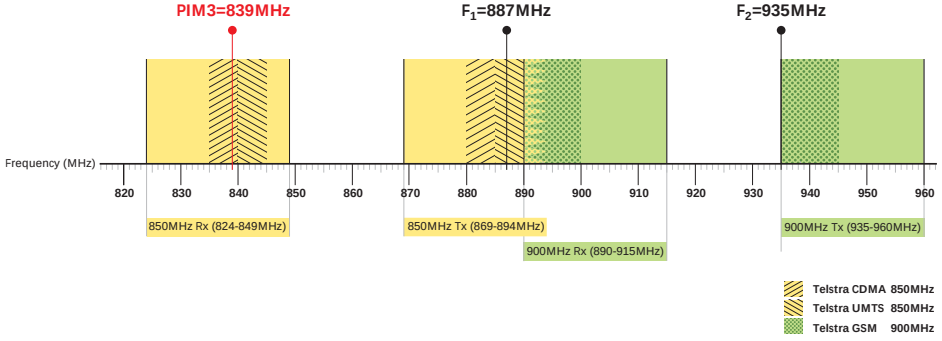
"These services have what I call the wrong 'site sense'," Johnston says. "They're not designed to be readily co-located. To make it all work, we've introduced some aggressive filtering and revolutionized our approach to assessing the PIM performance of each base station."

This led the carrier to work closely with its suppliers—including Radio Frequency Systems, Telstra's primary supplier for transmission line and associated accessories—to obtain RF components that deliver higher-than-normal PIM performance.

The reality of PIM

Passive intermodulation is generated when two or more signals are present in passive devices that exhibit a nonlinear response. In other words, when the relationship between current

Tesltra's CDMA 850MHz, UMTS 850MHz and GSM 900MHz services pose a co-location challenge: the transmit and receive bands of the three services occupy similar spectrum, leading to problematic PIM products and interference.



and voltage (or between electric and magnetic components of the propagating wave) is not completely linear, harmonic frequencies, and linear combinations of these, will be generated.

Third-order PIM signals are generally the most problematic for commercial networks, since they are most likely to fall in-band and at high power levels. They arise at $F_{IM3} = 2F_1 \pm F_2$, where F_{IM3} is the third-order PIM product (PIM3), and F_1 and F_2 are two individual signals on different frequencies—such as a pair of GSM carriers, or a combination of two GSM, CDMA and/or wideband CDMA (UMTS) signals.

"Practically, PIM can be generated anywhere along the RF feed system, or in the antenna itself," says Gerhard Wunder, RFS Director of International Business Development Transmission Line. "It's mainly an issue in duplexed systems, where the transmit and receive signals share the same transmission line. Where you have co-located services, you run the risk of coupling between services that can lead to PIM."

Johnston says that in the case of Telstra's network, third-order PIM products fall in the receive bands

for all three networks (GSM900, CDMA850 and UMTS850). For example, if F_1 is 887MHz (the approximate center frequency for the wideband 5MHz UMTS transmit carrier), and F_2 is 935MHz (a 200kHz carrier in the GSM transmit band of 935 to 943.4MHz), third-order PIM products fall at 839MHz and 2709MHz. The former (839MHz) falls directly in the receive band for CDMA (835 to 840MHz). (See illustration on page 7.)

"You can't filter them out when they fall in-band. And because the UMTS signal is spread across a 5MHz bandwidth, you get the intermodulation signals spreading as well," Johnston says. "The frequencies themselves are predictable, but the levels are less so."

Severe 'PIMpact'

If unchecked, the impact of PIM on the network could be severely detrimental, leading to a rise in the noise floor, desensitization of the receiver, and ultimately resulting in increased dropped calls. When a wideband signal is involved, the situation is worse, since it can reduce the capacity of the cell. Mobile CDMA handsets, for example, use bare minimum power for a decodable signal; but if there's a rise

RFS supplied coaxial transmission line and a specially designed ultra-low PIM connector for Telstra's Next G™ UMTS 850MHz deployment.

Connectorization of RFS's specially designed ultra-low PIM RAPID FIT connector (7/8-inch).

in the noise floor they have to power up to overcome it. The resultant battle with the receiver noise floor and the receive signal levels from different handsets could lead to a cell capacity reduction.

"PIM is not a new problem. It's always been there, and you can't avoid it. It's not a perfect world," Johnston says. "But Telstra's particular combination of frequencies has exacerbated the situation. The third-order product levels are directly determined by the PIM performance of the RF chain. One bad element could have a dramatic effect. So part of our strategy now is to make sure we have PIM under our control, by specifying strict performance standards and ensuring each installation meets those standards."

Cable pulling at Telstra's base station in Lara, near Melbourne in the southern Australian state of Victoria.

Wunder agrees that the only way to avoid the effects of PIM is to design low-PIM devices, citing three major causes of PIM: poor contact junctions, use of materials that exhibit some level of hysteresis, and foreign contamination. "Each of these issues must be taken into account when designing an RF device," he says. "Typically, cable exhibits extremely low PIM if state of the art production equipment is used to avoid any possible PIM source, so it's the connections and contact points in the RF feed system that are critical. This means careful connector design and installation is paramount."

However, while it is possible to ensure optimum conditions in a laboratory situation, the onsite reality is another story. "The fitting of connectors to coax can be a bit unpredictable," Johnston says. "It can depend heavily on the skill of the installer. Moreover, in the real world, the cables are often bent around a bit to connect to the antenna, and when the wind blows, the whole assembly can get shaken around. We've found the dynamic environment of the cable assembly can dramatically affect its PIM behavior."

PIM in the field

Telstra's means of field-testing PIM came in the form of a high-power portable PIM testing unit. Instead of being confined to the laboratory, this robust instrument is used onsite to measure the actual PIM levels generated by a specific installed system. It allows Telstra to perform routine tests of equipment using the proper International Electrotechnical Commission (IEC) standard (IEC 62037—*RF connectors, connector cable assemblies, and cables – Intermodulation level measurement)*, which specifies the use of two 20-watt carriers. According to Johnston, tests revealed that equipment which performed well in the laboratory didn't always meet Telstra's high PIM requirements when installed.

Tim Conboy, RFS Australia Business Manager Telecommunications, says that Telstra approached RFS in late 2005 requesting a modified transmission line connector that exhibited very low PIM under a range of dynamic situations. For the most widely used 7/8-inch coaxial transmission line, no connector on the market met Telstra's requirements at the time—and of the cable manufacturers Telstra approached, only RFS would commit to the task.

"Telstra was faced with a fast-track roll-out of over 5000 sites in about 10 months," Conboy says. "So we had to work quickly. RFS teams in both Australia and Germany put their heads together and developed a new connector that achieves the low PIM required by Telstra's network under a full range of dynamic conditions."

Wunder adds that the new connector was based on the 7/8-inch size of the RAPID FIT range, RFS's leading connector range, renowned for high performance, ease of installation and ruggedness. The main modifications were associated with the design of the inner conductor contact and the overall rigidity of the connector. These minimize any micro-movement of the contact point in a normal installed base station environment, where temperature fluctuations and wind-vibration (for example) are present. In terms of static PIM, the connector achieves the targeted specification of -162dBc.

PIM as routine

"We're very happy with RFS's modified connector—it has given us the network PIM performance we were looking for," Johnston says. "We've also been working with RFS to develop foolproof installation techniques, in order to minimize the possibility of poor practices when fitting connectors. It can no longer just be about how easy or fast a connector is to install. Connection quality is essential for PIM performance and mustn't be compromised. Against the odds, RFS committed to the challenge and actually did it. After the success of the 7/8-inch connector, we're now looking at the 1/2-inch."

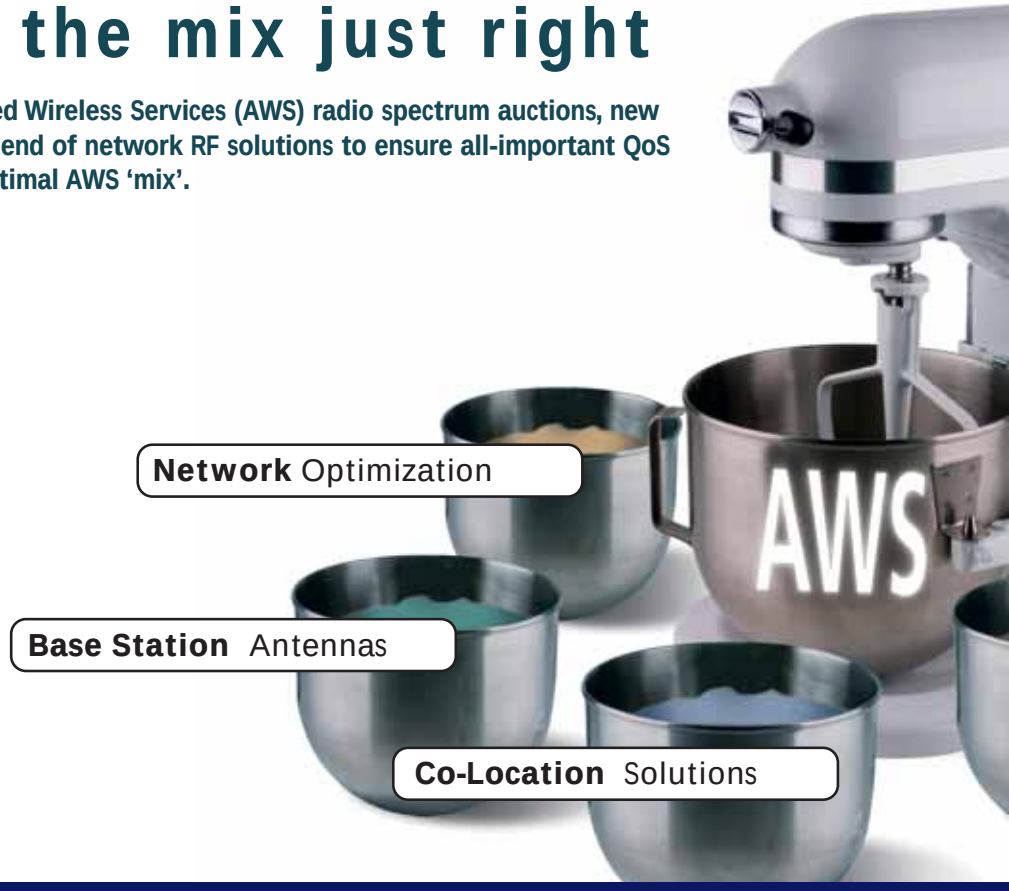
During Telstra's fast-track UMTS 850MHz 5000-base station deployment, RFS delivered around 20,000 of the modified RAPIDFIT connectors to complement many kilometers of its popular CELLFLEX 'A' foam-dielectric coaxial transmission line and associated accessories. Additionally and where possible, Telstra used RFS's factory pre-assembled jumper cables to ensure the required level of PIM performance for the flexible connections between large cables and devices. "At the end of the day, you just can't beat a good factory-soldered connector!" Johnston says.

The introduction of the Next G™ service and its associated PIM challenges has sparked a new—and not unwelcome—methodology for Telstra network deployments. Now, says Johnston, there are many portable PIM testing instruments within the company, and PIM testing of new base station installations is mandatory.

It is Johnston's view that soon onsite PIM testing will become as common and essential as the voltage standing wave ratio (VSWR) test. "This is the first time a carrier has performed routine measurements of PIM in installed base stations, and it's proving to be an excellent measure of the quality of the installation," he says. "I believe it will represent a step change across the board in the standard of installation, and consequently network performance. It will be needs driven—has been needs driven. Telstra just hit that need early."

AWS: Getting the mix just right

In the wake of the late-2006 US Advanced Wireless Services (AWS) radio spectrum auctions, new AWS spectrum owners need a tailored blend of network RF solutions to ensure all-important QoS and time-to-market. RFS presents the optimal AWS 'mix'.



The US Federal Communications Commission's (FCC) AWS spectrum auctions came to a close in September 2006. The auctions resulted in 1087 licenses being awarded to 104 entities, entitling each to a slice of the AWS band's nationwide 2 X 45MHz paired spectrum pie.

While the FCC has broadly described the intent of the spectrum as being for third-generation (3G) style "new and innovative fixed and mobile terrestrial wireless applications", the definition is genuinely non-prescriptive, with virtually no limitations on the technology or services deployed.

Although the new license owners have a wide variety of intended applications for the band, according to David Kiesling, Radio Frequency Systems Global Product Manager Wireless Infrastructure Solutions, they share a common driver. "The new licensees have paid for this spectrum and need to get return-on-investment—and fast. Maximizing that return comes down to speed of deployment and quality of service (QoS)."

Many months before the 2006 auctions, Kiesling explains, RFS commenced development of an AWS solution-set specifically to address these issues. Four distinct fronts were determined: the unique RF challenges of the AWS band, base station deployment issues, support of incumbent relocation, and network optimization.

The AWS RF challenge

The AWS band is the highest frequency allocated to-date by the FCC for cell-based wireless applications; its total span—from 1710MHz to 2155MHz—is enormous. AWS is provided as paired spectrum, with the uplink allocated to the 1710 to 1755MHz band, and downlink to the 2110 to 2155MHz band. A huge 355MHz gap separates the pair.

This gap makes AWS spectrum unique. "The total AWS uplink and downlink stretches from 1710 to 2155MHz, representing a 25 percent bandwidth. Accommodating this is a huge challenge for a base station antenna," Kiesling says. "Simple physics imposes slightly different antenna RF behavior at the lower and upper ends of this band. So, for optimum network performance it's essential that the uplink and downlink are balanced. When the AWS auctions were first announced, there wasn't a single antenna on the market that met these requirements."

A focused development program by the RFS team resulted in the Optimizer 'S-series' AWS/Personal Communications Service (PCS) broadband base station antenna, specifically designed to provide the closest performance matching of AWS uplink and downlink. The outcome is an azimuth horizontal beamwidth difference of less than seven degrees between uplink and downlink; and a gain difference of less than 1dB.

The new band also presents unique transmission attenuation challenges. "The broadband wireless data applications planned for the AWS band demand maximum signal-to-noise ratios and minimal bit error rate (BER)," says Larry Heisler, RFS Director of Marketing and Product Management. "At the band's elevated frequencies, transmission line attenuation will be an important factor in 'link budget' calculations, impacting on BER and signal-to-noise. Achieving premium attenuation—particularly in the downlink—is critical."

RFS's low-attenuation transmission line solution is its CELLFLEX 'A' *Premium Attenuation* transmission line. CELLFLEX 'A' offers attenuation improvements of up to eight percent, in cable diameters of 7/8, 1-1/4 and 1-5/8-inch. Most importantly, it retains its mechanical integrity with no concession on crush strength.

Tackling the overlay

The AWS spectrum will mostly be deployed as part of an overlay strategy; meeting the time-to-market objective is the over-riding consideration, Kiesling explains. "Taking advantage of as much existing infrastructure as possible minimizes capex, and reduces roll-out time. But, ensuring minimal interruption, or impact, on the QoS of existing services is also essential."

A further issue—both from a site zoning/planning permit and vertical real-estate rental opex perspective—is to provide compact tower-top overlay solutions of a size and weight

equivalent to existing single-band equipment. RFS's 'quad' polarized Optimizer S-series antenna fits the bill. "Using this antenna [in an AWS/PCS overlay] you are able to retain the same number of antennas on a sector, with PCS on one side and AWS on the other," says Kiesling. "From a zoning perspective this is a huge benefit!"

RFS offers similar 'two-in-one' AWS advantages with its new range of dual-duplex AWS tower-mount amplifiers (TMAs). Complementary to the Optimizer 'S' series, these TMAs are available in either dual AWS band,or dual-band AWS/PCS. Compact and high-performance, they provide the essential uplink amplification required in broadband wireless data services. These AWS TMAs show particularly low loss at both mid-band and band-edge, assuring QoS.

Rounding out these offerings are RFS tailored filter solutions to address co-location interference that may occur in AWS band overlays. Similarly, the company is developing diplexer solutions to permit feeder sharing.

Lastly, a nationwide overlay deployment demands streamlined logistics—a tightly coordinated network of delivery centers providing the correct RF solution-sets, to the right locations, at the right time. "Speed of network roll-out is ultimately dependent on supply logistics—an area where RFS excels, both in the US and abroad," Kiesling says. One solution used successfully by RFS is base station 'kitting'. The RFS AWS kitting solution will bundle together all RF elements required for a particular base station site—antennas, TMAs, cut-to-length transmission line, connectors, jumpers, and other accessories—for practical front-line deployment support.

Incumbent relocation

The AWS band is currently being used for various government and non-government services; all will require relocation, which must begin in 2007, and be completed by end 2010. A congressional mandate provides funds, acquired through the auction, to assist relocation from the government band uplink. Incumbent relocations from the privately-deployed downlink, however, are funded directly by the new licensees.

"With so much riding on AWS deployment, pressure on the incumbents is immense," says Asad Zoberi, RFS Area Product Manager, Microwave Antenna Systems. "But, the ability to reassess options and upgrade to new digital systems should compensate for much of the disruption."

Zoberi cites numerous alternatives for incumbents, including lease of existing T1 lines, deployment of fiber networks, and relocation of the AWS-band backhaul to other microwave bands. The latter, Zoberi reasons, is the most flexible and economic. "Microwave options can cover vast distances without extra costs, are quick to deploy, present superior reliability and offer payback periods of as little as two years," he says. "They also present the opportunity to upgrade to digital microwave technology, where capacity is less of an issue. Furthermore, microwave backhaul lets users have total control of the system."

Numerous band options are available potentially: some adjacent to the AWS band, plus a selection of alternative frequency bands. "The need for swift incumbent relocation will likely favor these microwave networks and RFS can provide premium antenna solutions in all major microwave bands," Zoberi says.

AWS network optimization

Once in place, the new AWS broadband wireless networks will be particularly demanding from an optimization perspective, with fresh challenges emerging from the Third Generation Partnership Project's (3GPP's) universal mobile telecommunications system (UMTS). "AWS carriers already anticipate that they are going to be spending a lot of time tweaking, trying this and trying that—all to make sure they have the best performance possible," Kiesling says.

Heisler concurs. "From a consumer perspective, network quality is the most important variable. It is one of the leading reasons for subscriber churn, with significant commercial impact. If your network can differentiate on the availability and speed of broadband data services, then you can drive and grow these data revenues."

The key optimization tools in this area relate to the big news of end 2006—finalization of the Antenna Interface Standards Group (AISG) version 2.0 standard for tower-top equipment control and monitoring.

"The wireless market and the AISG standard have reached a critical level of maturity," Heisler says. "Carriers now expect to be able to monitor their tower-top equipment and are no longer willing to use proprietary methods. ASIG version 2.0-compliance fulfils that, and RFS is very proud to offer some of the first compliant solutions in the country."

RFS's recently launched end-to-end AISGv2.0-compliant tower-top equipment control and monitoring solution-set comprises all key antenna line elements, including the AWS-band TMAs, antenna control units (ACUs), control network interface (CNI) and RFS's innovative Network Element Manager (NEM) software.

It is this area of network optimization where carriers will, according to Kiesling, "make it or break it" in the wireless broadband stakes.

"The network optimization challenge facing carriers running 3G services in the AWS band is probably the greatest we have seen to date," he says. "We know that QoS, service availability and data service speeds are the ultimate deciders for broadband wireless data subscribers.

"The good news is that our AWS solution set addresses these issues head-on. RFS has the most comprehensive AWS deployment and optimization solution set on the market—and it's in place and ready-to-roll right now."

Communicating from the coalface

As US mine safety requirements are intensified, RFS's RADIAFLEX radiating cable passes the test to deliver a unique wireless in-tunnel solution that is finding widespread application in US coal mines.

Coal mining is essential to modern living. A vital element of some of today's most valuable building blocks, coal is used to produce approximately 40 percent of the world's electricity, and is crucial in the production of steel and cement. Like all mining applications, underground coal mining can be hazardous. Continuous improvements in mining techniques, hazardous gas monitoring, and ventilation methods are minimizing potential risks, and providing modern coal miners with a safe working environment. The recent significant change in mine safety legislation in the US underlines the mining industry's ongoing commitment to safety.

In June 2006, US President George W. Bush signed the *Mine Improvement and New Emergency Response (MINER) Act*—the most significant US mine safety legislation in nearly 30 years. The new legislation further develops safety guidelines, set in place by the Mine Safety and Health Administration (MSHA), to improve mine safety nationwide. More particularly, it calls for the modernization of safety practices and the development of enhanced communications technology, requiring all mines to install wireless two-way communications and electronic tracking systems within three years.

One company that has been developing and implementing innovative mining solutions, long before the introduction of the latest US mine safety legislation, is leading US mining solutions group, Beitzel Corporation. A subsidiary of Beitzel Corporation, Pillar Innovations, has recently paired with leading mining automation and communication system provider, Becker Electronics (partner company of Becker Mining Systems), to develop turnkey wireless communications systems for some of the largest coal mines in the US.

RADIAFLEX—line in the mine

The Pillar Innovations/Becker Electronics-designed underground wireless communications system is based on a combination of passive and active RF technology. Typical networks comprise radiating cable, distributed point-source antennas, and numerous bi-directional amplifiers (BDA) to boost the signal along the length of the radiating cable system. The fully engineered turnkey system offers outstanding wireless coverage throughout the mine, and is founded on Radio Frequency Systems' popular RADIAFLEX foam-dielectric coaxial radiating cable.

RADIAFLEX radiating cables function as distributed antennas to provide wireless coverage in confined areas, such as tunnels, buildings and mines. Thousands of slots along the cable's length permit the tailored distribution of the RF signal into the surrounding space. Supporting multi-level UHF-based voice and data communications, the RADIAFLEX RCF12-50JFN half-inch diameter radiating cable represents a key component of the Pillar Innovations/Becker Electronics underground communications system, and is, therefore, an integral element of modern mine safety.

Underground approval

According to RFS US Business Development Manager, Suzanne Kasai, new mining communications systems and their components have to be certified 'MSHA approved', in order to comply with the new US mine safety requirements. The RADIAFLEX RCF12-50JFN half-inch diameter radiating cable achieved this approval. "The cable was subjected to a month-long qualification process to certify that it possesses advanced fire-retardant characteristics, crucial for mining applications," says Kasai. "It passed with flying colors." RADIAFLEX was one of the first radiating cable products to obtain the MSHA certification, cementing RFS at the forefront of wireless communications technology development.

In addition to obtaining MSHA approval, the RFS radiating cable was the focus of a number of end-user practical tests. In conjunction with Becker Electronics, Pillar Innovations deployed the RFS cable in numerous 'pillar and room' coal mines with differing geometries, and assessed its lateral coverage, and signal attenuation and propagation performance.

According to Pillar Innovations Project Manager, Adam Brenneman, RFS's RADIAFLEX cable presents the US mining industry with an attractive alternative to conventional hardwired telephony and legacy VHF cable. "We were extremely impressed with the performance of the RFS cable," says Brenneman. "Unlike 'yellow-stranded' VHF cable, the RADIAFLEX cable boasts high signal propagation, retaining signal strength down the line."

Cables that support UHF, such as RADIAFLEX, present many advantages over VHF systems. "The broadband nature of UHF communications enables the transmission of voice, data and video," says Brenneman. "UHF systems are much quieter and less susceptible to underground noise than VHF systems. UHF systems also allow users to seamlessly upgrade to wireless LAN (WLAN) services, which are becoming increasingly prevalent in mining applications."

Many on-site mine installation and maintenance crews prefer RADIAFLEX, as it is extremely robust, maneuverable and easy to install.

It is this performance characteristic that further sets RADIAFLEX apart from other radiating cables on the market. "Due to the presence of methane gas, all electrical equipment in coal mining installations, such as leaky feeder communication systems, must be certified as incapable of igniting the gas or 'intrinsically safe'. Therefore, such systems must use relatively low voltage and current," says Brenneman. "This limits the amount of power we can pump through the radiating cable. Overcoming this design limitation requires a highly engineered cable that can perform under these demanding conditions. RADIAFLEX does just that. It retains signal-strength in cable runs of up to 400 meters (1,312 feet), allowing us to minimize the number of in-line amplifiers. This provides a real cost saving to the end user."

Robust in the rock

The rugged and rocky nature of the mine environment—as opposed to road or rail tunnels—often presents a challenge to radiating cable installation. This is further complicated by the changing coverage area of a typical coal mine. As coal is removed, the mine changes shape and eventually the underground wireless communication infrastructure must be realigned to suit the new mine geometry.

"We've found that the on-site mine installation and maintenance crews prefer RADIAFLEX, as it is extremely robust, maneuverable and easy to work with," says Brenneman. "This is very important, as the radiating cable is continuously moved and reinstalled as the mine's layout changes and develops."

With cable runs in underground mine shafts often having to negotiate tight corners and unconventional distribution paths, RADIAFLEX is easily installed. Its low bending radii enables it to be fashioned around most underground structures," says Kasai. "Its inherent flexibility and high strength allow it to be deployed in the most complex cable network layouts."

In addition, the ambient temperature and humidity experienced in US coal mines can fluctuate dramatically, depending on the time of year. "RADIAFLEX cable is engineered to resist dust, moisture and humidity, making it the ideal choice for demanding conditions, such as those experienced in rugged coal mining environments," says Kasai.

A bright future in the dark

Pillar Innovations has deployed RFS's RADIAFLEX cable in a number of coal mining installations, including America's second largest long-wall coal mine, located in Pennsylvania. Many of the Pillar Innovations installations incorporate up to 27 kilometers (16.8 miles) of RADIAFLEX cable, providing the crucial link between mine site personnel, most of which are located several hundred meters underground.

"These wireless networks are future-proofed to some degree," says Brenneman. "While RADIAFLEX provides the required multiple voice and data channels, its broadband capabilities allow for sufficient expansion up to 6GHz."

With the US on the brink of establishing an industry based around converting its coal to transportation fuel—the so-called coal liquefaction initiative—the future of coal mining in America looks bright. "The growing momentum behind this initiative, coupled with America's enormous coal reserves (the largest in the world), indicate that underground communications systems are to become increasingly implemented in new and upgraded coal mines throughout the US in the coming years," says Kasai. "RFS is mining-ready, with approved technology and know-how to strongly support the US's mining communications development."

ClearFill—indoor/in-tunnel innovation

RADIAFLEX is an important element of RFS's innovative ClearFill suite of end-to-end wireless indoor solutions (WINS). The ClearFill suite is scalable, flexible and modular, encompassing solutions from 'plug-and-play' to the fully engineered. The advantages of the ClearFill solution are its flexibility, high reliability and inherently broadband nature, which facilitate the addition of new services to the WINS system.

ClearFill WINS at Macau Casinos

RFS's new ClearFill suite of wireless indoor solutions provides advanced wireless communications coverage to Macau's rapidly developing casino and holiday precinct.

Traditionally referred to as the 'greatest city of the east', the Chinese city of Macau has long held a reputation as a place of prosperity. Located on China's southeast coast and bordering the country's Guangdong Province, Macau is a Special Administrative Region (SAR) of China, and is allowed its own governance and economic policy. It is the only Chinese territory where casino gambling is legal.

In recent times, Macau has undergone an investment boom, which has seen a number of local and international casino chains open luxurious hotel and casino resorts. Macau's new casino and holiday precinct is situated within a five-hour flight of a potential market of three billion people. This is attracting increasing numbers of international tourists who are spending up big, both on and off the gaming floor. Designed to accommodate a vast number of visitors in lavish comfort, these state-of-the-art developments incorporate high-rise hotels, multiple gaming floors, shopping arcades, exhibition centers and even indoor sports stadiums. A number of resorts in Macau's rapidly developing casino and holiday precinct are equipped with world-class indoor wireless services and are founded on Radio Frequency Systems' ClearFill suite of advanced wireless indoor solutions (WINS).

Venetian's full house

Leading international hotel, gaming, and resort development company, Las Vegas Sands Corp, has contributed to the transformation of Macau's casino resort enclave with the recent opening of the Venetian Macau Resort. Complete with water canals and gondolas, the 3,000-room Venetian exudes Italian-style opulence, and occupies approximately one million square meters (10,700,000 square feet). The task of providing Macau's newest casino resort with wireless indoor communications was awarded to a select group of solutions providers, featuring RFS.

In conjunction with Ericsson, RFS designed the first phase of the Venetian's new wireless communications infrastructure and provided a range of passive WINS equipment. "RFS designed and supplied a distributed antenna network for the Venetian's hotel and the 50,000 square meters (538,000 square feet) of gaming area," says RFS Senior Regional Sales Manager, Charles Chong. "The ClearFill Line solution we've applied here consists of some 3,000 point-source antennas and 500 indoor panel antennas. These are linked together via RFS's CELLFLEX foam-dielectric coaxial transmission line."

The Venetian's broadband RF system supports four of Macau's commercial carriers, and has the capability to accommodate additional networks. Currently, the indoor network supports six distinct services: one code division multiple access (CDMA) at 800MHz, three global system for mobile communications (GSM) at 900MHz, and one GSM service at 1800MHz. The WINS solution also accommodates the hotel's terrestrial trunked radio (TETRA) service for internal and security communications.

"The Venetian's multi-carrier/multi-band ClearFill solution is truly future-proofed, as its broadband design supports frequencies up to 2.2GHz," says Chong. "It supports both second-generation (2G) services, and third-generation (3G) networks. This is particularly important, as the Macau Government has only just recently awarded 3G licenses."

In keeping with the casino's authentic appearance, all components of the RFS ClearFill solution had to be essentially 'invisible'. "RFS was able to provide camouflaged antennas to blend in with the Casino's luxurious décor," says Chong.

ClearFill—holding all aces

RFS's ClearFill suite of WINS solutions has found extensive application throughout Macau's burgeoning casino precinct. Global luxury hotel and gaming group, Wynn Resorts, recently implemented a wireless indoor communications system, featuring both passive and active ClearFill elements, at its Wynn Macau Resort. A combination of RFS point-source antennas, indoor panel antennas, CELLFLEX transmission line and in-line amplifiers make up part of the Wynn wireless communications system.

According to Chong, it is the flexibility of ClearFill that has made it the choice of many of Macau's casino operators. "The ClearFill suite is scalable and modular, encompassing solutions from 'plug-and-play' to the fully engineered," says Chong. "This rich mix of passive and active RF technologies for both harnessing and distributing the RF signal allows the Casino operators to fully customize their wireless installation."

With the Wynn Resort project complete and the Venetian installation recently on-line, RFS is turning its attention to the latest Macau casino development—the MGM Mirage/Pansy Ho Chiu-king-owned, MGM Grand Macau resort. "RFS is to supply a number of passive ClearFill solutions that are to be incorporated into the MGM Grand's wireless indoor infrastructure," said Chong. "With each casino project comes a range of different system requirements. The comprehensive nature of RFS's Clearfill suite means we will always have a solution."

The waking of India's wireless giant

As India's wireless growth outpaces the rest of the world, RFS is on-hand, providing solutions tailored to the region's wireless landscape.

Since ancient times, India has played a vital role in the development of global communications. An important junction in silk and spice trading routes, India acted as both source and conduit for cultural, artistic and financial exchanges between Europe and Asia. Today, modern India has turned the focus on itself, expediting the development of its national infrastructure—particularly communications.

Formed via the unification of independent kingdoms in South Asia, India has grown exponentially to emerge as a global leader in corporate governance and technology development. With the world's second-largest population (1.1 billion) and one of the fastest growing economies, India is attracting an increasing level of local and international investment. Nowhere is this more evident than in the local wireless communications sector.

Founded on code division multiple access (CDMA), and global system for mobile communications (GSM) technologies, India's digital wireless networks are run by 16 carriers across the country. Providing coverage to India's 18 mobile service areas (known as 'circles'), these carriers deliver second-generation (2G) and 2.5G services to over 130 million subscribers. This figure is increasing at a dramatic pace.

The current Indian wireless market is characterized by phenomenal growth. The number of mobile phone subscribers doubled between 2005 and 2006, and in recent months, India has added nearly six million subscribers per month, outpacing the growth of China. In a landscape that currently has a mobile tele-density of just two percent in the rural areas, and 40 percent in the urban areas, the potential for continued expansion is enormous.

Growing pains

India represents a key market for growth in the global wireless communications industry. Historically, the Indian Government has kept a tight grip on the airwaves, limiting foreign investment and allocating spectrum in small amounts. It is expected that the impending relaxation of these constraints will contribute to an explosion in India's wireless communications development.

The world's first corrugated aluminum transmission line, CELLFLEX Lite, will assist in realizing the affordable and rapid roll-out of wireless network infrastructure in India.

A relatively young industry, India's wireless communications sector has undergone a number of significant changes, following the deregulation of the country's telecom industry in the early nineties. The government's introduction of several National Telecom Policies, (notably NTP94 and NTP99) saw new players enter India's telecoms market, kick-starting the nation's wireless communications industry. The establishment of the country's first wireless communications network in 1995 marked the beginning of India's express wireless development.

Radio Frequency Systems has long been a key contributor to India's rapid wireless communications development, supplying equipment tailored to the nation's application requirements. Established in India in 2002, RFS has grown dramatically over the past years, echoing the rapid growth of the Indian wireless market. While advanced technology solutions providers such as RFS have played a vital role in supporting this growth, its main driver has been an insatiable domestic demand, coupled with steady waves of foreign investment.

In October 2005, the Indian Government amended its foreign direct investment (FDI) policy. Prior to this, foreign investment was limited to a maximum of 49 percent. That figure has been increased to 74 percent, enticing off-shore companies to inject much needed revenue into the Indian wireless communications sector.

Currently, India's wireless communications industry is holding its collective breath. The industry's regulatory authority, Telecom Regulatory Authority of India (TRAI) recently submitted a number of regulatory reforms to the Indian Government. The TRAI has recommended the freeing-up and allocation of spectrum, to allow the country's GSM and CDMA carriers to increase and enhance their services. These reforms are currently before Parliament and may assist the Indian Government in reaching its goal of 500 million subscribers by 2010.

CELLFLEX Lite is a foam-dielectric corrugated coaxial cable with an aluminum outer conductor and a copper inner. It is already being considered for several networks in India.

While this fast-track wireless development brings new communications flexibility to Indians, it also presents a range of region-specific challenges. Growth of this magnitude has not been encountered anywhere else in the world, and, as such, demands business models, rollout strategies and coverage plans unique to India.

Entering the interior

The task of providing India's population with efficient and affordable telephony is made more challenging by the country's diverse geography and socio-economic demographic. With approximately 70 percent of Indians residing in the country's rural areas, deploying communication networks—both wired and wireless—into India's interior is paramount.

With fixed-line telephony comparatively costly and time-consuming to roll out, wireless communications has emerged as the preferred technology. India's wireless subscribers already outnumber fixed line subscribers four to one. Providing wireless coverage to non-urban areas has seen network carriers adopt unique network operation and rollout strategies in order to cut costs and improve performance. According to RFS India Country Manager, Sukant Chakravarty, the introduction of the world's first corrugated aluminum transmission line, CELLFLEX Lite, will assist in realizing the affordable and rapid roll-out of wireless network infrastructure. "CELLFLEX Lite offers a lightweight alternative price point and performance combination for establishing the base station to antenna RF link," says Chakravarty. "With the rate of wireless network deployment at an all-time high, network providers in India are continually looking for alternative ways of delivering quality mobile services and coverage to both urban and rural users. Even though CELLFLEX Lite has been on the market for a very short time, it is already being considered for several networks in India.

"The electrical performance (attenuation, return-loss and intermodulation) of CELLFLEX Lite is actually superior to some copper transmission cables on the market," he says. "Its lightweight design, coupled with its single and multiple bending-radius capabilities, allow fast installation and make it ideal for congested tower-top applications."

Shared and streamlined

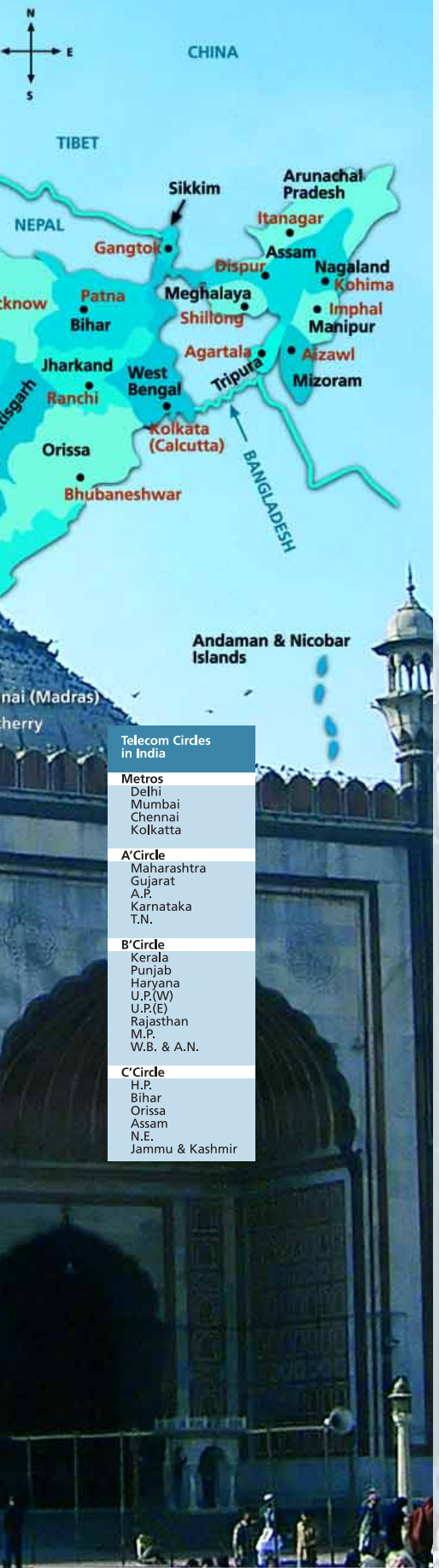
Although India leads the world in mobile telephony uptake rate, the country's mobile tele-density is still heavily weighted towards urban areas. As both urban and rural Indians gain increased access to a wider choice of carriers, inexpensive handsets, and wireless functionality, subscriber numbers are set to multiply dramatically.

Traditionally, nearly all of India's wireless carriers have established their own network infrastructures, competing for base station locations with India's exploding population. So serious is the issue of available base station sites (especially in India's metro coverage circles) that the TRAI has advised—in its most recent proposal to the Indian Government—that co-location and network sharing be enforced. Single-service base stations and antenna sites will become a thing of the past, making way for shared and streamlined wireless communication networks.

According to Chakravarty, co-location benefits are wide-ranging. "Urban operators will be able to rationalize their existing networks," he says. "Network sharing will simplify the physical network rollout process, accelerating growth in regions yet to receive wireless coverage." In both urban and rural applications, co-location allows operators to share costs associated with network rollout, upkeep and operation.

While the re-shaping of India's wireless sector is crucial to its growth, it raises significant network management challenges—interference in the co-location cases, and providing optimal coverage in new rural wireless deployments.

"RFS's RF conditioning solutions are tailored to address the co-location interference



India's wireless carriers currently deliver 2G and 2.5G services to over 130 million subscribers.

challenges facing operators in India," says Chakravarty. "Interference and dropped calls that can occur as a result of base station co-location can be minimized and avoided using RFS's range of bandpass filters. In addition to this, our series of diplexers and duplexers allow base station carriers to employ a single antenna array and feeder system for both uplinking and downlinking of multiple mobile services."

RFS is equally equipped to address optimal coverage issues faced in rural wireless deployments. "The RFS range of tower mounted boosters (TMB) provides the necessary downlink amplification required to ensure cost-efficient coverage of low population density areas," says Chakravarty. "The RFS TMB family provides carriers with the best combination of base transmitter station uplink sensitivity and downlink power."

Radio RFS

Infrastructure sharing in India is not limited to mobile phone networks. India's FM radio sector is currently being upgraded, with RFS playing a major role. Due for completion by the end of 2007, the three-stage common transmission infrastructure (CTI) project involves the design and construction of shared FM radio broadcast infrastructure to broadcast 240 radio stations into 91 Indian cities.

With extensive global experience in providing broadband RF solutions, RFS has been enlisted to design and supply 34 fully engineered FM RF broadcast systems, tailored to the local broadcast environment. The RFS combined broadcast system will allow the transmission of five channels—two government-owned channels and three private channels. "A combined antenna system allows all broadcasters 'top spot' on each tower, enabling increased coverage," says Chakravarty. "Engineering a combined antenna system represents a more streamlined solution and is often preferable to designing separate antenna systems."

With stage two of the CTI project nearing completion, 110 stations are now online and broadcast into 87 cities, representing a significant milestone in India's ongoing broadcast network expansion. With this investment in India's radio broadcast industry, it is not surprising that the recent unveiling of the final draft of India's Broadcast Bill has caused some controversy. India's latest Broadcast Bill directly contrasts the country's wireless communications policies, in that the Indian Government plans to increase the regulation of the broadcast sector.

RFS WINS in India

RFS India has recently consolidated its local presence by becoming a registered Indian business entity, and will complement its offices in Delhi with a distribution center in one of the nation's major cities. "RFS India now offers Institute of Electrical and Electronics Engineers-Thadomal Shahani Engineering College (IEEE-TSEC) certification, and is fully equipped to service India, Nepal and Bangladesh," says Chakravarty. "The imminent establishment of a local distribution center, coupled with local currency invoicing, will ensure rapid turnaround times on our comprehensive suite of RF solutions for any number of India's developing industries."

One of India's biggest growing markets is the construction industry, with approximately 3,000 new buildings scheduled for completion by 2009. With the construction of new shopping malls, cinema complexes, high-rise residential buildings and office skyscrapers, comes an escalating demand for wireless coverage inside buildings and tunnels.

"This growing number of populated structures in India is demanding wireless coverage for commercial cellular services, safety radio, WiFi [wireless fidelity], WiMAX [worldwide interoperability for microwave access] and even mobile TV," says Chakravarty. "RFS's innovative ClearFill suite of end-to-end wireless indoor solutions (WINS) has been designed specifically for just these types of applications. Clearfill solutions range from 'plug-and-play' technology to a fully engineered turnkey system." Launched at ITU World Telecom in Hong Kong in November 2006, ClearFill is already being considered for a number of Indian construction projects.

With the Indian Government set to release new spectrum for network expansion, India looks set to speed ahead on its multi-lane wireless communications development highway. As 2G services make their way into the country's rural areas, India's city-dwellers eagerly await the arrival of 3G services in the coming years. "RFS is 3G-ready, equipped with the technology and expertise to 'hit the ground running'," says Chakravarty. "This is truly an exciting period in India's wireless development and RFS India is thrilled at being on the front line."

Quadruple-play at CTIA 2007

Converged tower-top solutions—and their ability to meet the increasing performance demands of emerging quadruple-play applications—will be the main theme for Radio Frequency Systems at the 2007 CTIA Wireless exhibition. To be showcased at the exhibition, RFS's new tower-top suite represents a unique convergence of advanced RF passive and active, control and monitoring, and mounting and assembly solutions.

"The introduction of 'mobility' into the multi-play mix has enormous implications for the wireless industry in general, and the tower top in particular," said RFS Director of Marketing and Product Management, Larry Heisler. "The ability to access voice, Internet, and television/video without being tethered to a fixed point via cable is hugely attractive to subscribers and carriers alike—it is the ultimate convergence outcome."

Featured at CTIA Wireless 2007 will be RFS's AISG v2.0-compliant system, plus the company's Advanced Wireless Services (AWS) solution set. RFS will also showcase its new Optimizer 'S-Series' suite of broadband PCS/AWS-band base station antennas, tower-mount amplifiers (TMAs), transmission line solutions, and RF conditioning and network management tools. The Orlando expo will also see RFS exhibit its integrated cluster system, as well as offering attendees a 'sneak preview' of its 'in-development' WiMAX remote radio head (RRH).

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Wireless Indoor Solution for Beijing Metro Line 4

A computerized vision of Beijing's sparkling new metro concourse.

By its completion in 2009, Beijing Metro's Line 4 will be the major north-south underground railway artery serving the booming metropolis of China's capital. Linking 24 stations over a distance of 29 kilometers (17 miles), the line will carry hundreds of thousands of people each day from Longbeicun to Majialou, in an end-to-end journey taking just 47 minutes.

Radio Frequency Systems China has been awarded the contract to provide a wireless indoor solution (WINS) to support the line's dedicated 800MHz terrestrial trunked radio (TETRA) essential radio system. Coverage will be required not just along the twin-bore tunnels, but also throughout the stations' concourses, a parking/warehouse complex, depot, and multi-level office building—all linked to an Operations Management Center.

Engineered by RFS China, the system will utilize RFS wireless indoor coverage technology—a truly hybrid solution ideal for the longest tunnels and for midsize to large in-building complexes. The RFS system comprises fiber-fed repeaters with optical converters to drive the signal through an otherwise passive distribution network of radiating cable and/or distributed antennas.

For Beijing Line 4, the metro tunnels will be covered using RFS's popular leaky coaxial foam-dielectric RADIAFLEX RLKU radiating cable.

Coverage for the station concourse areas and equipment rooms, on the other hand, will be provided by an innovative RF distribution network incorporating point-source indoor antennas and RLKU radiating cable. This will allow the demanding signal level requirements of -87dBm to be met in all areas. A TETRA base station will be located at each underground station.

Coverage to the parking/warehouse and depot/office complexes will be via an 'RF on fiber' system. This will entail a sophisticated head-station (or master unit), which feeds the RF signal via optical fiber to remotely located optical repeaters (or remote units). The remote units, in turn, will feed the signal through a passive distribution network of antennas at the parking/warehouse and depot/office sites.

The construction of Beijing Line 4 is just part of a mammoth infrastructure upgrade being readied for the 2008 Olympic Games and beyond. Installation of RFS's WINS system will commence in third-quarter 2007; the line is scheduled for completion by 2009.

RFS partners Nokia at 2007 Pan-Am Games

Several principal event locations at this year's Pan-American Games will receive indoor wireless coverage enhancement to support TIM network's global system for mobile communications (GSM) coverage. Nokia Networks has been contracted to provide the complete indoor network design, installation and site support for the duration of the games, which are to be held during July in Rio de Janeiro, Brazil.

Developed in partnership with Radio Frequency Systems for TIM Brazil, the new indoor wireless network will support tri-band GSM voice and data coverage (GSM 1800MHz, and capacity for expansion to GSM 900MHz and UMTS 2100MHz services in the future). The enhanced in-building coverage system is founded on RFS's innovative ClearFill suite of wireless indoor solutions (WINS).

RFS's ClearFill Space2 solution features a hybrid mix of active fiber optic technology and passive RF distribution networks to deliver optimum coverage in large indoor areas and tunnels. It will be deployed at key Pan-American and Para-Pan-American Games venues—such as the Riocentro Convention Centre, the Maracanã Complex (including the stadium), the Maracanãzinho Gymnasium, and the Célio de Barros Track and Field Center.

The new indoor system will support next-generation wireless services, including high-speed packet access (HSPA), and incorporates a monitoring and alarm system interfaced to a higher-level monitoring and response system.

"This project demonstrates TIM's commitment to all Brazilian subscribers," said Antonio Jose Martins, TIM network manager in Rio de Janeiro. "With huge crowds expected at the games, we anticipate extending the capacity of the TIM network for voice and data transmission, plus text and multimedia messaging."

This article appears courtesy of Nokia.

Maracanã Complex (Rio de Janeiro)

PREVIEW for next issue

West Pearl Tower provides a view on DTV

Towering high above Chengdu city, in Sichuan Province, central-western China, is the West Pearl Tower. This 17-level, 339-meter (1110-foot) tower is now home to a plethora of FM radio, and VHF and UHF television broadcast facilities, servicing the 10 million inhabitants of Chengdu city and its surrounding districts. Commissioned in late-2006, this multitude of broadcast antennas was designed, developed and commissioned by Radio Frequency Systems. In total, the facility supports 10 separate 10kW FM radio services, two 10kW VHF-band TV services, and potentially three 2X30kW UHF TV services.

The intent of this broadcast installation was twofold: to rationalize and consolidate a disparate array of smaller broadcast facilities located outside the city, and also to furnish a broadcast facility that is ready for China's next wave of digital technology—to be ready for digital television (DTV). How the project unfolded, and just what its success indicates regarding DTV's future in China, will be explored in the next issue of ***STAY CONNECTED***.

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