The nation is showing signs of emerging from the worst economic slowdown since World War II, yet things have been anything and everything but slow at TCS. We have been completing projects, securing new business and have added staff members. Here is a snapshot of what we have been doing lately:

**Newberry, South Carolina**: TCS awarded contract to conduct needs assessment and to recommend improvement to VHF and UHF radio systems.

**Bowling Green, Kentucky**: TCS awarded contract to recommend a modernization scheme for the City’s aged 800MHz trunked radio system.

**Ada County, Idaho**: Awarded contract to audit existing 700MHz three site simulcast system and to recommend coverage enhancement solutions.

**Kansas City, Missouri**: Ongoing contract amended to include development of RFP specification for a new Project-25 simulcast trunked radio system. Completed vendor proposal evaluations and are now conducting contract negotiations with the recommended radio vendor.

**Riverside, Missouri**: Awarded contract to complete assessment to expand Kansas City trunked radio network to support City of Riverside operations.

**City of Independence, Missouri**: Retained by the Mid America Regional Council to enhance existing 11GHz microwave subsystem to OC-3 bandwidth and improved path segment reliability.

**Mid America Regional Council**: Awarded a series of contracts to improve area-wide microwave and radio communications. Additional project to assess radio communications needs for public health and present options

**Roanoke Regional Airport Commission**: Awarded contract to analyze and recommend alternatives for improved public safety and airfield communications.

**Missouri Hospital Association**: Awarded contract to audit and recommend enhancements to statewide hospital communication systems.

**Hancock County, Mississippi**: Awarded multiple contracts to expand existing 700MHz trunked radio system and to recommend maintenance alternatives.

**St. Tammany Parish, Louisiana**: Awarded contract to provide ongoing radio consulting services.

**Jackson County, Mississippi**: Awarded contract to provide ongoing radio consulting services.

And, we have one major surprise brewing, so stay tuned for a breaking news announcement later this month!
Customer Service – Where Did it Go?

If you are a child of the 1950’s, who doesn’t remember the milkman, the paper boy, the mailman, the dry cleaners delivery man, the Fuller Brush man, the egg man, the telephone man or certainly the television repairman?

It seemed that our homes, while growing up, were the focal point of every sort of repair and home convenience service one could imagine. School kids were even picked up by a shiny yellow school bus like clockwork every school day morning and safely delivered back home the same afternoon.

With the progression of Time, one would have expected even more home services now that many of us Baby Boomers are deep into middle age. Yet, what do we have?? Self serve everything!

Buy a drink at the hamburger joint and you have to fill your own drink cup with ice and beverage and then cart your own trash to the receptacle.

Have a problem with your telephone? Well, forget about the telephone man coming to the house and repairing the phone for you….for the cost of your normal monthly bill.

*Kids today don’t know that a TV repairman ever existed!*

For the so-called sake of convenience, we seemingly pay more and more money for less and less service. I don’t know about you, but at times it seems once you walk into a big box department store you become an immediate part-time unpaid worker since you have to find it, carry it to the register and then check it out, YOURSELF!

Perhaps this is why many people are so startled when a company provides what, in the 1950s, would have been considered merely courteous service. It seems so out of place in today’s so-called Modern World. Call me a relic, but when I find good service I make a point to come back. Where to find it? Try the smaller locally owned firms first. While they often can’t match price with the Big Boys, you’ll get far better service and by folks with fully engaged brains…which makes the small difference in price priceless!

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800 MHz Rebanding Factoid: Time Delay Interference and its Impact on EDACS Simulcast Trunking.

800MHz REBANDING HAS STRETCHED THE TECHNICAL RESOURCES OF ALL PARTICIPANTS: Sprint, Consultants, Vendors and Licensees alike. Many have had to scramble to add personnel in a valiant attempt to maintain schedule, but simulcast public safety radio networks of all types are taking much longer to successfully plan, retune and close out.

A majority of these systems are based on Motorola Smartnet/Smartzone technology, but a large number are also Harris (formerly GE, Ericsson, ComNet and M/A-COM) designs utilizing EDACS technology. Technical personnel new to the 800MHz Rebanding Game may not appreciate the significant technical

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Continued differences involving Smartnet versus EDACS simulcast operations, so perhaps an illustration of key differences is in order.

From a propagation and self-interference aspect, a key difference lies in the control channel signaling scheme. In Smartnet, the control channel utilizes four-level keying whereby the transmitted signaling rate is actually half that of the equivalent data rate. Thus if the signaling rate was 3,900 bps, the actual transmitted information is half that rate. In the EDACS control channel, the equivalent signaling rate is a faster 9,600 bps, but since only two-level frequency shift keying is used by EDACS, the actual transmitted signaling rate is also a much faster 9,600 bps. Keep this in mind: Smartnet/Smartzone signaling is at an actual rate which is less that one fourth that of EDACS. We will see, later, that this lower signaling rate offers relative benefits in terms of amplitude and phase stability.

For a simulcast radio system’s user fleet to properly decode data transmitted by the control channel, it is important that the data not be corrupted by the relative propagation time delays from the various simulcast sites in a given design. In the case for Motorola, their actual transmitted signaling rate is so relatively slow (as compared to EDACS) that simulcast sites can have comparatively larger geographic separation distances and not introduce significant receiving anomalies in terms of control channel data. In the case of EDACS simulcast site placement, particularly in those systems involving more than two sites, all active sites must have comparatively short geographic site-separation distances (12 miles or less) to prevent time-related propagation interference…termed Time Delay Interference, or TDI.

As most trunked radio systems today are designed for portable radio coverage, either manufacturer’s design for simulcast sites leads to smaller site separations in order to meet in-building coverage specifications, yet the difference in site placement between Motorola and Smartnet configurations is more favorable to Motorola versus EDACS. In Motorola designs, due largely to its reduced transmitted signaling rate, it is also possible to more readily use omni-direction simulcast transmit antennas whose added benefit is that the loss of a channel at one site has less of an impact on delivered on-street and even in-building coverage. A large EDACS simulcast design, where more that two site coverage overlaps are involved, often requires the use of highly directional antenna systems to better manage TDI performance. Some of the panel antennas used in the Henry County (Georgia) simulcast design, for example, exhibit a near 40db front-to-back (10,000:1) radiation difference to where some infrastructure sites have little to no coverage overlap.

In an EDACS simulcast configuration, one should also note that the loss of a channel base station at any given site requires that channel to be removed from service from all remaining sites. This is necessary to eliminate channel-to-channel coverage differences and to prevent TDI from operation using a smaller subset of active channels (as would result immediately if operations without all base stations being active would give rise).

This sort of simulcast coverage failure protection as required by EDACS is not inherent in Motorola Smartnet designs. In a Motorola system, loss of a channel base station at any simulcast site does not, in itself, require that channel be disabled at the remaining sites. Thus the concern and attention given by EDACS-proficient engineers on their assigned 800MHz retunes is seemingly not as fully appreciated by those skilled in Motorola systems (particularly while negotiating some complex EDACS FRAs….but that is another story). More simply put, loss of an individual channel base station during a peak-period retune would have far less user impact on a Motorola Smartnet configuration as compared to an equivalent EDACS network. The key difference being that in the Smartnet configuration, the remaining base stations for that one channel would remain operational during the defect’s period whereas in the EDACS configuration, loss of that same single base station would result in that channel’s surviving and operational base stations at other infrastructure sites being removed from service to prevent TDI.

Retuning an eight or ten site, twenty or more channel simulcast system serving many thousands of radio users is never a walk in the park no matter whose technology is at play. Take time to fully understand how simulcast technology works…and more importantly…what steps should be taken to preserve its operational integrity.
The Evolution of Radio Communications Equipment

Today, many amateur and professional radio operators affectionately term the radio equipment of the 1950s and 1960s as Boatanchors. And having restored a goodly number of these behemoths myself, I can say the name is aptly earned as these desk crushing radios easily weigh in the 75 to 100 pound range. These sets enjoyed as much artistry in a visual sense as engineering for the functions performed.

Ergonomics played a key role in the design of these battleship radios (I say “battleships” because steel ... and lots of it ... was a significant component used in their manufacture). Modern day equipment is amazingly more sophisticated from an electronics sense, but to my taste lacks style and ergonomic function. Spin the tuning knob on the National receiver picture to the lower left of this ham operator and the feel is heavy, yet seems silky smooth to the touch and is just right. Dim the shack lights so the backlit frequency dial can be clearly seen, with the warm glow of vacuum tube filaments peering through the cabinet perforations (coupled with a neat JD on the rocks) and you’re in business!

Performance has obviously improved with the advent of solid state components, digital signal processors and frequency synthesis. Yet, sadly, our new radios lack the raw sex appeal of a bygone era. For the most part, they are too small, use too much plastic, feel cheap and lack style.

So, those considering a fling in the business of high frequency radio communications equipment design, set the competition on its ear. Put all of Today’s great solid state, software defined technology into a large box with the user interface of a Collins 75A4, National 303 or Hallicrafters SX115…and watch them fly off the shelves.
True Radio Interoperability

There is no doubt that the conclusion of World War II brought with it an avalanche of new and improved communications technologies that were quickly embraced by the nation’s public safety agencies. Police and fire departments throughout the county scrambled to add the more rugged and flexible VHF FM radios that had been battle tested throughout campaigns in Europe, Africa and the Pacific Ocean.

In the period after the War, public safety had principally one radio band available for wide area communications and that was VHF Low Band, a piece of spectrum between 30-50MHz. And since communications centered on only one band, interoperability or the means to effectively communicate between departments or agencies was relatively simple. The four VHF Low Band antennas on this then state-of-the-art mobile command post of the late 1950s illustrates that point, as the police official easily communicates with his allied helicopter resource.

The obvious advantages of radio communications far outstripped the available low band channels, so new spectrum in other frequency bands was made available by the government. While this new spectrum allowed more to take advantage of radio’s expansive capabilities, users lost an attribute that was taken for granted: interoperability.

This past summer, with the final release of huge radio spectrum resources in the 700MHz band and coupled with 800MHz refarming, public safety agencies will soon enjoy the freedom and capability to interoperate within a combined 700/800MHz landscape. More exciting is the new era of software defined, multi-band radios where frequency band segments can be brought together in a manner unworkable before. Eventually, as new radio systems are funded and implemented, public safety will have regained what was lost in the 70’s, 80’s and 1990s: the ability to seamlessly communicate with counterparts via a single radio device.
VHF Refarming – An Unintended Upside

The FCC’s transition date for narrowband operations below 512MHz is steadily approaching. Some affected licensees are starting early to retune their systems and are reaping an interesting benefit: interference resolution and improved coverage. Before we discuss the interference issue and its subtle way of weighing down a VHF radio system’s operational effectiveness, let’s revisit the band plan first.

When public safety VHF low and high band allocations were planned by the FCC there was no repeater system technology in play. Operations were conducted base-to-mobile on a single licensed frequency. The gradual availability of portable radio devices brought with it a need for improved radio coverage, thus the concept of a repeater system was borne. Repeater stations use two frequencies to support a communications channel where prior base-to-mobile configurations only required one. And, the two frequencies had to be separated by a reasonable amount (no less than 500KHz) for the repeater station to operate in a manner that did not cause self-induced desensitization. Yet, the first widespread use of repeater stations was in the most technically viable of the two available VHF band segments: high band (150-170MHz).

Coordination of frequency assignments fell into the lap of volunteer frequency coordinators, whose job was to disperse frequency assignments in a manner that created the least practical interference to in-place operations. As the use of repeaters became more widespread, it became correspondingly more difficult to assign frequencies whereby a repeater station’s input channel was not subject to distant interference caused by high powered base station (simplex) operations.

The FCC was not asleep at the switch while this was playing out and realized that all new spectrum allocations should accommodate and protect repeater operations. This was accomplished in both UHF and 800MHz bands with the creation of input and output channel pairs having a specific amount of frequency separation.

For example the frequency separation at UHF is 5MHz between repeater input and output frequencies and is 45MHz for 800MHz allocations. And, by having established a band plan for input and output signal paths, the problem of a high powered base station causing interference to a distant repeater receiver input was eliminated.

With the proliferation of UHF and 800MHz radio system, and comparatively little real growth in the VHF band, many system owners and even younger radio system designers have never faced the issue of severe co-channel repeater desensitization. What makes matters worse, of course, is that little Band-Aid fix-all used to provide a modicum of privacy on shared radio spectrum: continuous tone coded squelch (i.e. PL or Channel Guard).

Tone Coded Squelch or PL makes life easier for radio users on shared radio channels by allowing their radios to become active only for calls associated with themselves and not others. It also effectively masks repeater receiver desensitization, which results in a huge talk-in range reduction for portable radio users, particularly, but even mobile radio are noticeably affected if an extreme repeater desense condition exists.

The mistake many inexperienced radio engineers and technicians make is to simply verify a repeater’s normal sensitivity and believe all is well. All may be well for the equipment, but once the receiver’s antenna is connected, that 0.2uv sensitivity could have degraded to an effective sensitivity of 10uv or more! While completing a rebanding assessment for a new client, we and they were both shocked to find one of their repeater sites had a degraded repeater sensitivity of -80dbm, which is the equivalent of a 22uv noise floor.

To better illustrate the point to non-technical folks, consider you and your spouse walking into a reception hall two hours before the event. In the quiet of the room it is possible to easily converse, even when separated by fifty or one hundred feet. Add twenty guests (each having a series of private conversations) and the ambient noise level increases dramatically. In the worst case, you and your spouse may be within inches of each other and still not be able to converse. This is illustrative of the noise floor concept and analog FM receivers. A high noise level at a receiver/repeater site results in degraded talk-in coverage.

In the next issue of Backscatter, we will discuss how to measure a receiver’s effective sensitivity and tricks of the trade to track down interferors. See you soon!
Perhaps this is a case of someone taking the “don’t get mad…get even” approach a bit too far, but clearly someone had a lot of anger to work out on this hapless Police and Fire communications tower. Many public safety radio towers are located at remote, high sites that have few and very infrequent visitors.

Appearance reinforces the perception of infrequent personnel traffic as, frankly, many of the antenna sites we routinely visit in the course of needs assessments and infrastructure surveys look like garbage dumps.

Abandoned transmission line shipping reels, peeling paint, sagging roofs, transmission line “rats nests” and high weeds all but encourage mischief. Yet, we see these conditions so often that our TCS Hall of Shame is never absent of potential candidates. This tower is shared by a county sheriff’s office and fire department. Needless to say, this site was inoperable for quite some time and underscores just how vulnerable to intentional catastrophic damage vital communication systems remote sites can be.

What to do? First, maintain your sites! Make sure they look like someone all but lives there as this step alone may likely discourage that special jackass weighing the worth of a random act of gross stupidity. Next, don’t advertise your presence…particularly outside for anyone to see! Sure, all FCC station licenses must be posted, but located them safely on interior equipment cabinets. Do not install departmental emblems or signage on outdoor antennas, transmission lines, front doors or towers as this brings unwanted attention to your single-most vulnerability.

This tower was fielded by the removal of two bolts and by temporarily relocating the climber safety cable to the back of a truck’s trailer hitch. It probably was all over in fifteen minutes or less. Visit your remote tower sites today and develop a plan that makes them clean, safe and secure.
TCS Hall of Shame: We've Entered the Radio Twilight Zone

In this issue of the Backscatter Journal, our journey through Time and Space takes us to a location that, for reasons of conscience, we cannot disclose.

These two radio equipment shelters, although alien in appearance, are actually in use and fully operational to some degree. Notice the excellent grounds keeping and, particularly, the hot-stand-by power feed to the building on the left: two parallel indoor-style Romex cables, flapping in the breeze. Most would consider this an egregious violation of the National Electric Code, but since a part of each cable end is located indoors shouldn’t that be good enough?

Note also the superb attention given to transmission line security and the nod to Motorola R-56 grounding standards. No radio system can operate effectively without electrical power. So the designers of this site went to great lengths to ensure the survivability of electrical service in Category 5 hurricane force winds. One can clearly see the combined paper and scrap plastic strain reliefs installed at the power pole attachment point. And, in the interest of safety, no fewer than three nails have been used to secure the pipe strap attachment hardware. Spare power wiring is installed on the pole to facilitate the installation of backup equipment in emergencies.

Mr. Walter Gallinghouse (Communications Center, Inc.) was kind enough to bring this site to our attention as a potential candidate to the TCS hall of Shame. What a fine candidate it is! He was pleased to report finding hard evidence that this mission-critical power pole is inspected once a decade, to verify that its resident termites are still holding hands and maintaining wood fiber integrity.

Finally, every radio technician and engineer knows the importance of a proper entrance for electrical power cables. In fact, it is a topic covered in the National Electric Code. But, in the heat of a summer installation, who has time for details when a glob of RTV and some spare Romex insulation will do an admirable job in itself.

In all seriousness, horrendous installation and maintenance errors such as these are much more common than one might think. We see them all the time, which is why we enjoy sharing them with you!

PS: If you have a candidate for the TCS Hall of Shame, don’t be shy. Please send them to me at: nick.tusa@tusaconsulting.com