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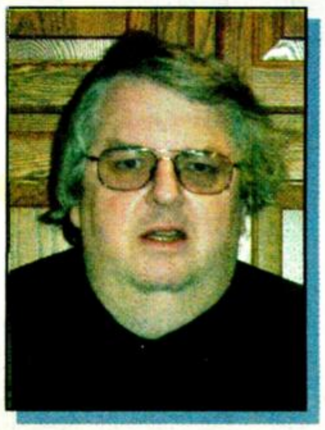
ENGINEERING EXTRA

April 5, 2006

CONSULTANT INTERVIEW



Roy Stype

Engineer Says He's Come 'Full Circle'

Roy Stype Recalls Working With Carl E. Smith and Favorite Directional Array Projects

by Steve Callahan

Every radio station needs a good consulting engineer. He or she can help a station maximize its signal and guide the licensee through the maze of FCC technical rules. A full-service consulting firm can be invaluable to a station's local engineering staff when a big

SEE STYPE, PAGE 18

Crossed-Field Antenna Performance

Controversial Antenna Design Fails To Deliver on Early Promises

by Valentino Trainotti Senior Member, IEEE and Luis A. Dorado Student Member, IEEE

Lately, short and Crossed-Field Antennas have attracted broadcast and amateur community attention. The CFA was developed in the last decade of the 20th century, trying to obtain a compact transmitting antenna for low- and medium-frequency AM bands. The CFA is used to get a low-profile antenna and a supposed performance similar or better compared to a quarter-wave monopole.

In this paper, the CFA has been exhaustively studied using the Transmission Line Method in order to obtain an equivalent network and the antenna performance. Due to the lack of theoretical data to explain the CFA behavior, the TLM has been validated by means of Moment Method simulations and some available experimental data.

Any linear antenna is a Crossed-Field Antenna (CFA) in the far-field zone, because the electric and magnetic fields are perpendicular to each other and to the direction of wave propagation, which is indicated by a real Poynting vector. Nevertheless, the term CFA was intended to be used for an antenna where the existence of the crossed fields is everywhere in space, which is known as Poynting Vector Synthesis.

Calculations demonstrate that this is a utopia, because on the antenna metallic structure both fields must fulfill the boundary conditions and a near-field zone always exists, where induction fields predominate.

The CFA has a short monopole (monopole 1) and another very short monopole (monopole 2) with a metallic disk as a top-load, which is parallel and close to the earth. If the dimensions of both metallic structures are much smaller than the wavelength, then the Transmission Line Method (TLM) for the analysis of top-loaded monopoles applies [see reference 1, page 12]. The monopole 1 axis passes through a hole at the disk center, and the ground below the antenna is covered by a thin metallic layer. See Fig. 1.

Input power is injected into the antenna by two generators. The first one is connected to monopole 1 base and ground and the second one is connected to monopole 2 disk and ground. For this paper, the CFA was thoroughly analyzed from the input impedance and radiation properties points of view using Maxwell equations through the TLM and a Moment Method approach.

No serious theoretical analysis of this antenna has been found in the technical literature, and only partial analysis has been made by software simulations [2]–[5] or some experiment with actual and reduced scale models [6]–[10]. These efforts do not explain clearly the actual CFA performance; inventors' explanations are too vague and do not support their invention by means of a clear theory in order to assure its working performance [11]–[16].

EQUIVALENT NETWORK

The CFA can be considered an array of two tightly coupled short monopoles. The first one is a monopole of height H_1, while the second one is a monopole of height H_2 with the disk as its top-load; see Fig. 1. Thus, the CFA can be analyzed as a two-port network.

Monopole 1 base and ground are the port 1 terminals, while metallic disk (monopole 2) and ground are the port 2 terminals. Fig. 2 shows the antenna equivalent network, which can be characterized by its impedance parameters; the monopole 1 self-impedance, Z_{11}; the monopole 2 self-impedance (disk), Z_{22}; and the mutual impedances, $Z_{12} = Z_{21}$, between them.

By using impedance parameters, the

SEE CFA, PAGE 4

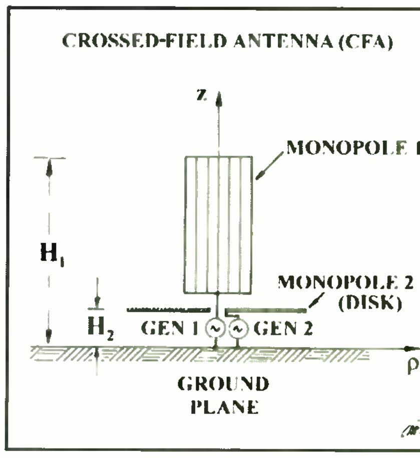


Fig. 1: Crossed-Field Antenna (CFA) feeding system

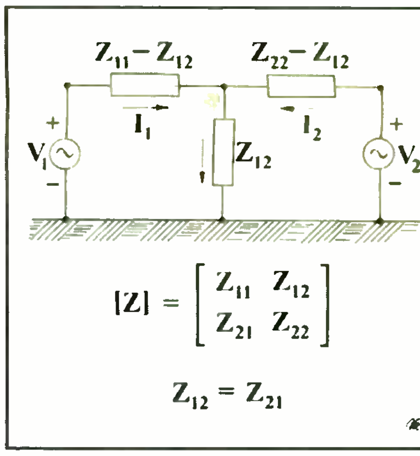


Fig. 2: Crossed-Field Antenna (CFA) equivalent network

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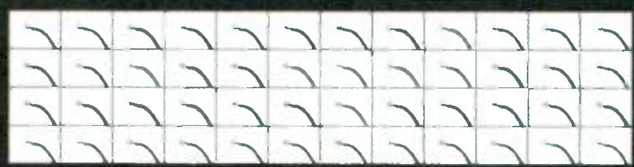

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FROM THE TECH EDITOR

by Michael LeClair

Sound Quality, Coverage: Worth the Loss of Reception?

I left off last time before looking at the other side of the AM IBOC digital conundrum — what about interference?

As anyone with even a passing interest in radio has heard by now, there has been loud opposition in some areas to the use of AM IBOC. A range of arguments has been made against AM IBOC; the most amusing to read are the often laughable cost estimates thrown out with now-escalating abandon.

One recent claim I came across declared it would cost $150,000 to convert a 1 kW AM non-directional station. Others have railed that the annual fee to Ibiquity to operate their system is in excess of $5,000 per year in perpetuity.

It doesn't take too much effort to arrive at the real facts around the cost. For perspective, in our case the total cost of converting our 1 kW AM station was around $35,000, including a one-time license fee of $5,000. Not free but an order of magnitude cheaper than some statements I have encountered in the world of online list servers. We could have spent more, but the performance was quite good with only this amount.

However, the most powerful argument against AM IBOC has to be the accusation that it will cause widespread interference to other stations on the AM band. Given the amount of sideband energy that IBOC requires in order to deliver digital coverage and quality, the potential for interference is quite real.

DIGITAL WHITE NOISE

In fact, it is easy to hear the effects of putting up digital sub-channels by simply tuning an AM radio off from the center frequency of a station running IBOC digital. The primary digital QPSK carriers resemble what is essentially white noise — a band of frequencies about 5 kHz wide centered at 12.5 kHz on either side of the AM channel frequency, all at an equal average amplitude 28 dB below the carrier.

Secondary digital QPSK carriers are closer to the center channel frequency and at lower average amplitude (around 35 dB below carrier). Essentially the entire range of frequencies between 5 kHz and 15 kHz is filled with this digital energy.

The typical AM analog tuner will demodulate this energy as audible white noise. In the region between the analog channel and the digital sideband, the filtering effects of a limited bandwidth tuner (in most cases AM tuners have a rapidly falling frequency response above 3 kHz) causes a strange interaction that has been said to resemble the sound of crickets on a summer evening.

A number of studies have been done that have tried to address the question of whether this interference will have a major impact on the AM band. Proponents on both sides of this issue can point to well-executed and carefully analyzed works that support their claims in favor or against IBOC. A common study methodology was to analyze the performance of a selection of "typical" AM radios in the presence of sideband energy and then calculate a level of predicted interference.

It was my interest to actually take a listen to the results in our specific case. This is only one data point in a large, nationwide pool of AM stations, but it represents actual results, not statistical outcomes derived from looking at a group of averages. As mentioned previously, our station is located at 1240 kHz on an unlimited local channel at 1 kW. The AM tuner I used for these listening tests is a Kenwood model KTC-HR100, HD Radio-compatible tuner.

Before turning on the IBOC carriers, I drove around to observe whether there were other AM stations receivable in the immediate vicinity to our transmitter. As it turns out, this was too close to allow my car radio to pick up any signals within 30 kHz above or below our frequency. I had to move further away to allow the tuner to open up enough to pick up other AM stations. In our case a distance of about three miles worked well as a test reception location.

At that distance, I was now able to pick up the following frequencies: 1220 kHz, 1230 kHz and 1260 kHz. The first of these was coming from a 1 kilowatt station about 60 miles away and was no more than a feeble scratching that could be made out as modulation. I considered this station out of its coverage range and not of great importance to any observations about IBOC.

The station at 1230 kHz was actually coming in pretty well. This allocation is another 1 kW unlimited local channel licensed to a city approximately 68 miles to the north of our station. It is possible to understand the long-distance coverage of this station only by knowing the station is located on the ocean and its signal follows a seawater path all the way down the coast to us.

The third station on 1260 kHz is located 58 miles away. It is a 5 kW DA with a lobe in our direction and also benefits from a partial seawater transmission path. The reception quality on 1260 kHz was fair to poor. In certain locations it came in relatively clear, but any attempt at mobile reception was hampered by noise fades and dropouts due to overhead power lines. At its best it was quite noisy but modulation was clear enough to easily discern the music format.

Using my cell phone to dial up the remote control, I turned on the digital to see what the effects would be.

As expected, the 1230 kHz station suffered almost complete obliteration. The digital energy was substantial enough that any reception of this station was no longer possible. On 1260 kHz, there was noticeable increase in the noise floor below the audio. The induced noise was smooth and not unlistenable but it was clearly audible below the modulation.

Moving further away from our station, I did some fairly unscientific tuning back and forth to see about how far the interference continued. On 1260 kHz, it lasted about five more miles until the noise was blended into the general background noise that had been there from the start. On 1230 kHz the interference went out audibly over ten miles.

RECEPTION INTERFERENCE

So what can we conclude from these informal listening tests? At least two stations that formerly had some kind of reception in areas a few miles away from our transmitter now had new interference with which to contend.

> The most powerful argument against AM IBOC has to be the accusation that it will cause widespread interference to other stations on the AM band.

The impact was quite severe on the 1230 kHz station. The 1230 kHz situation points out the vagaries of the AM allocation system where the distance between these two stations would ordinarily be more than sufficient to prevent interference, but due to the seawater transmission path, reception for this station spreads out for very long distances along the coast. This kind of

SEE LECLAIR, PAGE 24

IN THIS ISSUE

CFA

CONTINUED FROM PAGE 1

standard network equations can be written in matrix form as follows [17]:

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \cdot \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

Admittance parameters, Y_{11}, Y_{22} and $Y_{12} = Y_{21}$ also will be required and are obtained by inverting the impedance matrix.

Self-impedances of monopoles 1 and 2 can be obtained from their current distributions [1]; see Figs. 3 and 4. The mutual impedance Z_{21} is the ratio between the open circuit voltage in port 2 and the current flowing in port 1. If the voltage V_2 is due to the electric field E_{z1} between the disk and ground, caused by the current I_1 in port 1, then:

$$Z_{21} = -\frac{E_{z1} H_2}{I_1}\bigg|_{I_2=0}$$

The electric field E_{z1} is the near field produced by monopole 1 in the space surrounding the antenna. Alternatively, the network parameters can be calculated using the Method of Moments (MoM), which has been used by means of our own software [18].

Monopole 1 input voltage, V_1, is taken as the phase reference and monopole 2 input voltage, V_2, is given by:

$$V_2 = K V_1 e^{j\phi_2}$$

Thus, K is the amplitude ratio $|V_1|/|V_2|$, while ϕ_2 is the voltage phase difference. The port 1 input impedance is:

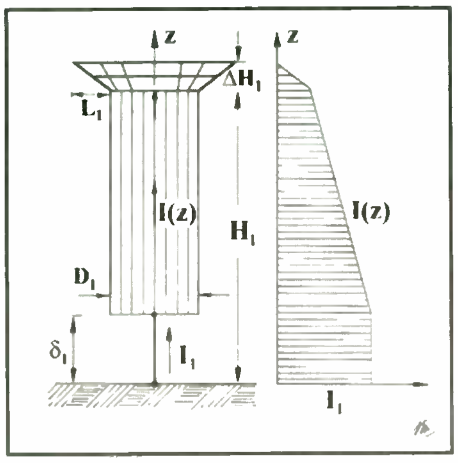


Fig. 3: CFA monopole 1 current distribution.

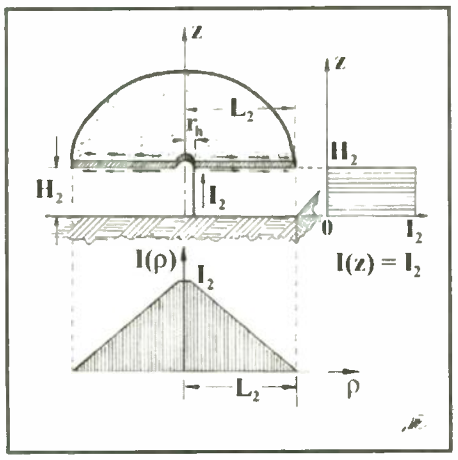


Fig. 4: CFA monopole 2 and top-loading disk current distributions.

$$Z_1 = R_1 + jX_1 = \frac{V_1}{I_1} = \frac{1}{Y_{11} + Y_{12} K e^{j\phi_2}}$$

The port 2 input impedance is:

$$Z_2 = R_2 + jX_2 = \frac{V_2}{I_2} = \frac{K}{Y_{12} e^{-j\phi_2} + K Y_{22}}$$

The active power produced by generator 1 is $W_1 = |I_1|^2 \times R_1$ and that produced by generator 2 is $W_2 = |I_2|^2 \times R_2$. Then the total input power, $W_{in} = W_1 + W_2$, becomes:

$$W_{in} = |V_1|^2 \, (G_{11} + 2 K G_{12} \cos\phi_2 + K^2 G_{22})$$

Where:
G_{11} and G_{22} are self-conductances
G_{12} is the network mutual conductance

The input power depends on cos $\phi 2$.
There are three distinct operating areas:

When $G_{12} > 0$, the input power is maximum for $\phi 2 = 0$ (360°) and minimum for $\phi 2 = 180°$.

When $G_{12} < 0$, the input power is maximum for $\phi 2 = 180°$ and minimum for $\phi 2 = 0$ (360°).

When $G_{12} = 0$, the input power is constant for any value of $\phi 2$.

In Fig. 5, a CFA operating in the first regime is shown where the currents of both generators are in phase. In Fig. 6, a CFA operating in the second regime is shown where the generator currents are out of phase. When $G_{12} = 0$, the CFA will operate either as in Figs. 5 or 6 according to the highest voltage generator.

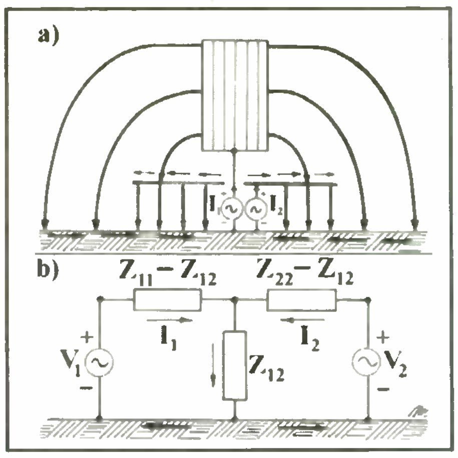


Fig. 5: At top, CFA operating in the first regime (I) $G_{12} > 0$. At bottom, CFA equivalent circuit.

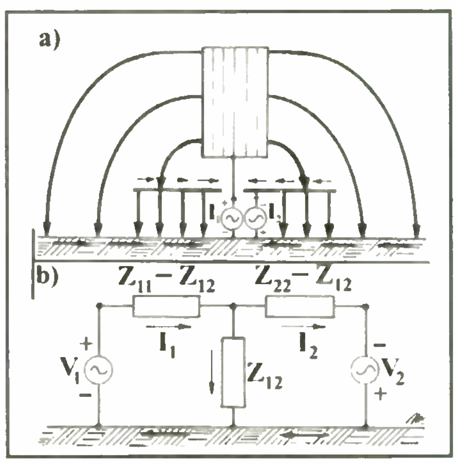


Fig. 6: At top, CFA operating in the second regime (II) $G_{12} < 0$. At bottom, CFA equivalent circuit.

ELECTROMAGNETIC FIELD

The electromagnetic field radiated from the antenna is the sum of the radiation produced by the array of the two CFA monopoles. Monopole 1 is a short vertical antenna and monopole 2 is practically a Hertz monopole made by the disk and its feeding vertical lead. The near field of a short monopole has been determined in [1].

In the far-field zone, when spherical coordinates are used, the CFA total far electric field E_θ will be the sum of the monopoles 1 and 2 far electric fields, $E_{\theta 1}$ and $E_{\theta 2}$, then:

$$|E_\theta| = 60 \, |I_1| \, \beta H_e \frac{\sin\theta}{r}$$

Where:
r = the distance from the antenna and θ is the zenith angle. Thus, the CFA directivity is D = 3 due to the sin θ far-field radiation pattern. The CFA effective height H_e is:

$$H_e = H_{e1} \left| 1 + \frac{I_2 H_{e2}}{I_1 H_{e1}} \right|$$

Where:
H_{ei} = the i-th monopole effective height.

Therefore, the CFA radiation resistance is given by:

$$R_{rad} = 40 \, (\beta H_{e1})^2 \left| 1 + \frac{I_2 H_{e2}}{I_1 H_{e1}} \right|^2$$

Taking into account the efficiency, η, and gain $G = \eta D$, the effective far electric field becomes:

$$|E_\theta| = \frac{\sqrt{30 \, W_{in} \, G}}{r} \sin\theta$$

This equation gives the non-attenuated radiated electric field, and is exactly the same as for any standard short monopole. The actual field intensity along the earth is affected by the soil physical constants and the diffraction due to the spherical earth [19], [20].

ANTENNA TUNING AND BANDWIDTH

In the antenna circuit there are losses in conductors, insulators, tuning system and in the earth surface within a circle half-wavelength in radius. Insulator losses are very low compared to the other and can be neglected.

In order to tune the antenna, a coil is connected in series to each port, obtaining real input impedances. Then, self-impedances can be written in the following way when losses and tuning coils are present:

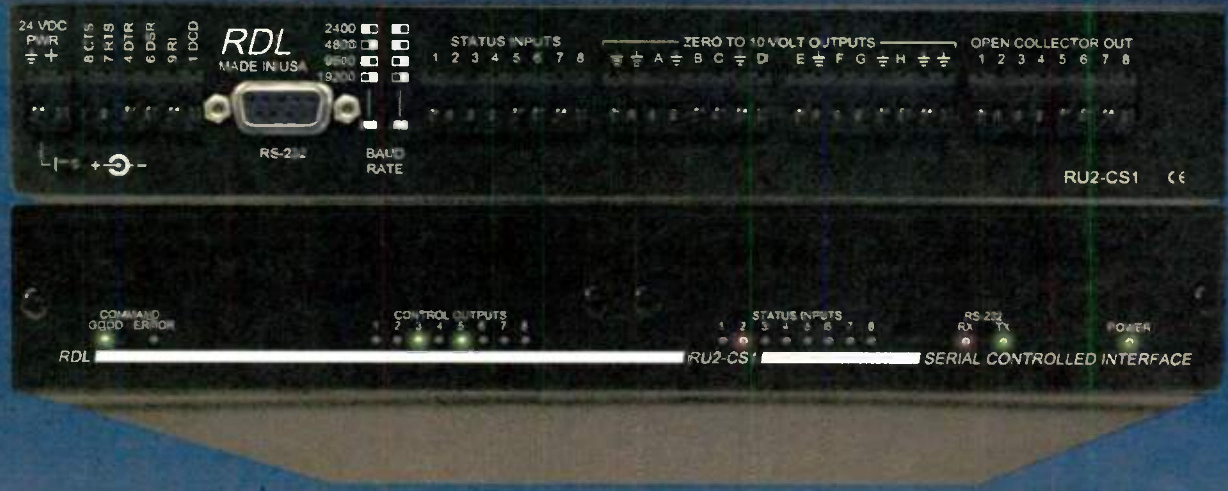
$$Z_{ii} = Z_{ii}^{\infty} + R_{ci} + R_{gpi} + R_{Li} + j X_{Li} \qquad i = 1, 2$$

Where:
$Z_{ii}^{\infty} = R_{radi} + jX_{ii}$ is the i-th monopole self-impedance with no losses and no tuning coils.
R_{radi} is the i-th monopole radiation resistance.
R_{ci} is the i-th monopole conductor resistance, taking into account the skin effect.
R_{gpi} is the ground plane loss resistance due to the i-th monopole current distribution and soil conditions.
R_{Li} and X_{Li} are the i-th monopole tuning coil resistance and reactance.

The mutual impedance Z_{12} is practically not affected by the antenna losses, because it depends on the very near-field distribu-

SEE CFA, PAGE 6

GET EVERYTHING UNDER CONTROL



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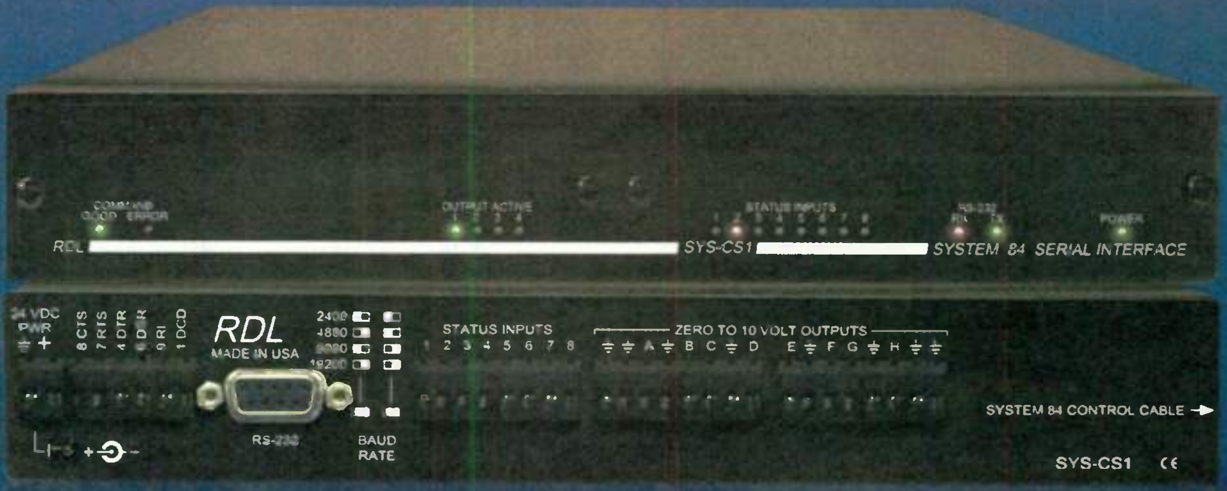

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CONTINUED FROM PAGE 4

tion, which is not appreciably affected by the finite soil conductivity [21], [22].

On the surface of the earth, a thin metallic layer of radius R_0 is laid down (artificial ground plane). The ground plane loss resistances, R_{gpi}, are determined from the near magnetic field or surface current density on the ground surface. Then, the power dissipation is calculated in a circular boundary half-wavelength from the antenna base [1].

For VSWR calculations, it is convenient to define a CFA average reflection coefficient as:

$$|\Gamma| = \sqrt{\frac{W_1\,|\Gamma_1|^2 + W_2\,|\Gamma_2|^2}{W_{in}}}$$

TABLE I

CFA DIMENSIONS IN METERS.

Monopole 1 height	H_1	10
Barrel diameter	D_1	3.0
Monopole 1 top-load length	L_1	0.0
Barrel base height	δ_1	1.5
Monopole 1 wire radius	a_1	$6 \cdot 10^{-3}$
Monopole 2 (disk) height	H_2	1.0
Disk radius (monopole 2 top-load length)	L_2	2.5
Disk hole radius	r_h	0.05
Monopole 2 wire radius	a_2	$6 \cdot 10^{-3}$
Artificial ground plane radius	R_0	5.0

TABLE II

CFA EQUIVALENT NETWORK MATRIX.

METHOD	Z_{11}	Z_{12}	Z_{22}
TLM	2.18 – j410	0.11 – j124	0.09 – j856
MoM	2.13 – j430	0.20 – j117	0.13 – j844

EXAMPLES

A. CFA operating windows

A CFA is analyzed at 1 MHz, with the antenna dimensions indicated in Table I and over average soil (σ = 10^{-2} S/m, ε_r = 10). The CFA equivalent network impedance matrix can be seen for both methods, TLM and MoM, in Table II. In this example,

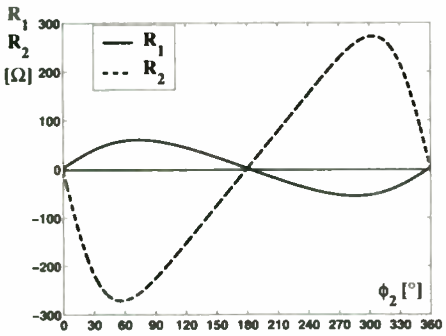

Fig. 7: CFA input resistances R_1 and R_2 as functions of ϕ_2 for K = 1 and over average ground.

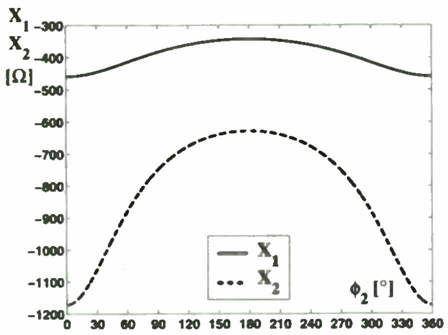

Fig. 8: CFA input reactances X_1 and X_2 as functions of ϕ_2 for K = 1 and over average ground.

monopole 1 is a barrel, built up by 24 copper wires of radius a_1. (See Fig. 3.)

As a first analysis, input impedances of both antenna ports are calculated as functions of voltage phase difference ϕ_2 for K = 1 and over average ground, Figs. 7 and 8. In Fig. 7, negative input resistances R_1 and R_2 can be seen for some ranges of ϕ_2, while in Fig. 8 the input reactances X_1 and X_2 are always negative.

There exist two small windows, difficult to appreciate in Fig. 7, where both input resistances are positive, permitting the antenna operation. One window is located in the neighborhood of ϕ_2 = 180° and the other near ϕ_2 = 360°. Input impedances are shown in both windows in Tables III and IV.

TABLE III

CFA INPUT IMPEDANCES IN 180°-WINDOW.

ϕ_2	R_1	X_1	R_2	X_2
deg	Ω	Ω	Ω	Ω
179.4	2.30	−343	−0.71	−629
180.2	1.70	−343	1.32	−629
180.6	1.39	−343	2.34	−629
181.0	1.09	−343	3.36	−629
181.4	0.79	−343	4.37	−629
181.8	0.49	−343	5.39	−629
182.6	−0.12	−343	7.42	−629

TABLE IV

CFA INPUT IMPEDANCES IN 360°-WINDOW.

ϕ_2	R_1	X_1	R_2	X_2
deg	Ω	Ω	Ω	Ω
358.0	−0.12	−459	15.7	−1171
358.4	0.42	−459	12.2	−1171
358.6	0.69	−459	10.4	−1172
358.8	0.96	−459	8.67	−1172
359.2	1.50	−459	5.14	−1172
359.4	1.77	−459	3.37	−1172
359.8	2.31	−459	−0.16	−1172

In order to tune the antenna, opposite reactances of infinite merit factors are connected in series to both ports. If the 180° window is chosen, these reactances are X_{L1} = 343 ohms and X_{L2} = 629 ohms. Under this condition, the input resistances and reactances of both ports are shown in Figs. 9 and 10, where they have a small variation as functions of ϕ_2. The input impedances of both ports are practically real, in a region close to ϕ_2 = 180°.

In the 180° window, when the generators have the same voltage amplitude (K = 1), the antenna is operational because the input powers on both ports are positive for ϕ_2 between 50° and 290°. In this case, the equivalent network mutual conductance is negative, G_{12} = -0.253 S, and the antenna operates as in Fig. 6.

If the 360° window is chosen the tuning reactances are X_{L1} = 459 ohms and X_{L2} = 1172 ohms. Under this condition, the input resistances and reactances of both ports are shown in Figs. 11 and 12, where they also have a small variation as functions of ϕ_2. The input impedances of both ports are practically real for ϕ_2 between 0° and 100° and between 240° and 360°.

In this case, the antenna is operational too, because the input powers in both ports are positive. Also, because the equivalent network mutual conductance is positive, G_{12} = 0.165 S, the antenna operates as in Fig. 5.

From this analysis, the range of the voltage phase difference ϕ_2 was obtained under antenna resonance condition, when the input impedances of both ports are practically resistive. The ϕ_2 value of interest in these ranges or windows is that which permits to have the input powers, W_1 and W_2, under control, with a given relationship W_2/W_1.

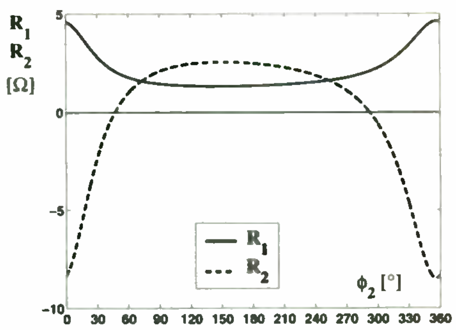

Fig. 9: Tuned CFA input resistances R_1 and R_2 as functions of ϕ_2 for K = 1. The 180° window can be clearly seen where R_1 and R_2 are positive.

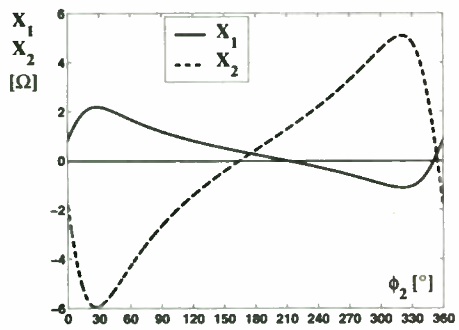

Fig. 10: Tuned CFA input reactances X_1 and X_2 as functions of ϕ_2 for K = 1 and in the 180° window.

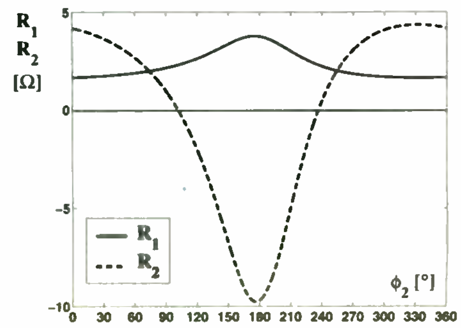

Fig. 11: Tuned CFA input resistances R_1 and R_2 as functions of ϕ_2 for K = 1. The 360° window can clearly be seen where R_1 and R_2 are positive.

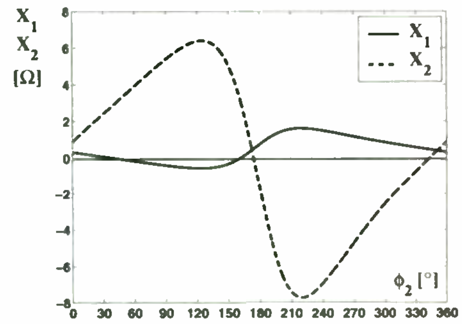

Fig. 12 caption: Tuned CFA input reactances X_1 and X_2 as functions of ϕ_2 for K = 1 and in the 360° window.

B. CFA performance

Knowing the CFA operation in both windows, input impedances, near-field, wave impedance, radiation resistance, efficiency, gain and far-field strength at 1 km for 1 kW input power can be calculated. In Tables V and VI, the results of the CFA 180° and 360° windows can be seen.

A monopole with the same height (H_1/λ= 0.0333), taken as reference, has a radiation resistance R_{rad} = 0.71 ohms, a gain G = -0.12 dBi and a field strength of E = 171 mV/m at 1 km for 1 kW of input power. The CFA has the same 1 kW input power with 500 W applied to each port. From the two CFA operating windows, as seen in Tables V and VI, a small loss (0.57 dB) and a small gain (0.31 dB) can be seen with respect to the gain of the reference monopole.

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TABLE V

CFA PERFORMANCE IN 180°-WINDOW.

K	ϕ_2	R_1	R_2	R_{rad}	G	E
–	deg	Ω	Ω	Ω	dBi	mV/m
1.6	130.6	1.04	3.47	0.59	−0.69	160
1.7	155.3	1.04	3.50	0.59	−0.69	160
1.8	174.4	1.04	3.52	0.59	−0.69	160
1.9	191.9	1.04	3.54	0.60	−0.68	160
2.0	209.6	1.05	3.55	0.60	−0.68	160

TABLE VI

CFA PERFORMANCE IN 360°-WINDOW.

K	ϕ_2	R_1	R_2	R_{rad}	G	E
–	deg	Ω	Ω	Ω	dBi	mV/m
2.2	310.1	1.14	7.57	0.79	0.18	177
2.4	341.3	1.14	7.46	0.79	0.19	177
2.6	4.873	1.14	7.39	0.80	0.19	177
2.8	27.48	1.14	7.32	0.80	0.19	177
3.0	54.52	1.14	7.22	0.80	0.19	177

C. Tuning coil losses

Tuning coil losses are included for several merit factors Q_L. These losses also are included in the reference monopole of height $H_1/\lambda = 0.0333$.

In Table VII, the effect of the merit factor Q_L is clearly seen in the monopole behavior when it is placed on an average ground. Bandwidth is for VSWR = 2, and the electric field strength is shown at a distance of 1 km for an input power of 1 kW. The same effect is seen in Tables VIII and IX for the CFA in the 180° and 360° windows. When losses are increased, a corresponding increase in the antenna bandwidth is clearly obtained. Nevertheless, a decrease in gain occurs for the monopole and CFA in both windows.

D. Near-field

With tuning coils of merit factor Q_L = 200, near electric and magnetic fields have

TABLE VII

SHORT MONOPOLE TUNING COIL EFFECT.

Q_L	±Δf	η	G	E	E
–	kHz	–	dBi	mV/m	dBμV/m
∞	1.8	0.32	−0.12	171	104.65
400	2.7	0.22	−1.80	141	102.98
200	3.5	0.17	−3.00	123	101.77
100	5.2	0.11	−4.71	101	100.06

TABLE VIII

180°-WINDOW CFA TUNING COIL EFFECT.

Q_L	±Δf	η	G	E	E
–	kHz	–	dBi	mV/m	dBμV/m
∞	1.4	0.28	−0.69	160	104.09
400	2.2	0.17	−2.82	125	101.95
200	3.1	0.13	−4.24	106	100.53
100	4.8	0.08	−6.18	85.1	98.59

TABLE IX

360°-WINDOW CFA TUNING COIL EFFECT.

Q_L	±Δf	η	G	E	E
–	kHz	–	dBi	mV/m	dBμV/m
∞	1.2	0.35	0.19	177	104.96
400	2.1	0.20	−2.11	136	102.66
200	2.9	0.15	−3.61	114	101.16
100	4.7	0.09	−5.59	91.0	99.18

been calculated for both windows; specifically, for K = 1.8 and ϕ_2 = 174.4° (Table V) and for K = 2.4 and ϕ_2 = 341.3° (Table VI). In Fig. 13, the near electric field for the CFA and the reference monopole over average ground can be seen as a function of distance, for an input power of 1 kW.

The wave impedance in space, Z_0, just above the earth surface in the air, is the ratio between the near electric and magnetic fields on the ground plane, and can be seen in Fig. 14 as a function of distance. It is practically the same for both CFA windows, so only one curve for magnitude and one for phase are presented.

In Table X, wave impedances are calculated for the CFA and a reference monopole of the same height (H_1/λ = 0.0333), at 1 MHz and over average ground.

It can be noticed that the CFA wave impedance is very close to that of the reference monopole. Furthermore, no Poynting Vector Synthesis (PVS) [23] can be seen, because the wave impedance is reactive close to the antenna and real at distances greater than half-wavelength ($Z_0 \cong 377$ ohms). Therefore, the CFA behaves like any

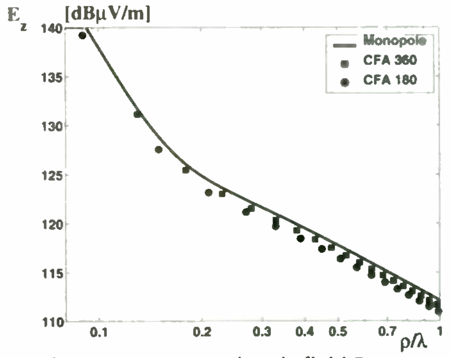

Fig. 13: CFA near electric field E_z as a function of distance ρ/λ at 1 MHz for average ground (σ = 10^{-2} S/m, ε_r = 10) and an input power of 1 kW.

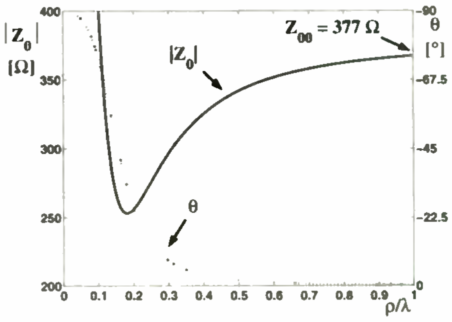

Fig. 14: CFA wave impedance as a function of distance ρ/λ at 1 MHz.

short monopole, because a reactive near field zone exists close to the antenna structure and the radiated field starts at a distance near to half-wavelength.

TABLE X

CFA AND SHORT MONOPOLE WAVE IMPEDANCES.

ρ/λ	$\lvert Z_{0\,CFA}\rvert$	θ_{CFA}	$\lvert Z_{0\,MON}\rvert$	θ_{MON}
–	Ω	°	Ω	°
0.1	387.7	−73.9	385.5	−73.8
0.2	254.9	−25.4	254.8	−25.3
0.4	325.4	−3.47	325.3	−3.47
0.6	351.6	−1.04	351.6	−1.03
0.8	362.1	−0.44	362.1	−0.44
1.0	367.1	−0.22	367.1	−0.22
3.0	375.4	−0.01	375.4	−0.01

TABLE XI

SHORT MONOPOLE OVER WET SOIL.

Q_L	±Δf	η	G	E	E
–	kHz	–	dBi	mV/m	dBμV/m
∞	1.3	0.46	1.36	202	106.13
400	2.2	0.27	−0.85	157	103.93
200	3.0	0.20	−2.30	133	102.47
100	4.7	0.13	−4.25	106	100.52

E. Artificial ground plane effect

The effect of the circular metallic ground plane of radius R_0 on the antenna performance over average ground is analyzed for tuning coils of merit factor Q_L = 200.

In Tables XII, XIII and XIV, the short monopole, 180° and 360° window CFA performances are presented as functions of the artificial ground plane radius R_0. Field strength E at 1 km is for an input power of 1 kW.

F. Height effect

CFA gain and bandwidth have been analyzed as functions of monopole 1 height, H_1, with a disk radius L_2 = 2.5 m, over

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average ground, and with tuning coils of merit factor Q_L = 200. A reference monopole of the same height has also been calculated, Figs. 15 and 16.

Fig. 15 shows that the gain difference is smaller for greater antenna heights. This means the disk has a deleterious effect on the antenna performance. At the same time, Fig. 16 shows a better bandwidth of the monopole compared to the CFA for any height.

TABLE XII

MONOPOLE PERFORMANCE OVER METALLIC GROUND PLANE.

R_0	$\pm\Delta f$	η	G	E	E
m	kHz	–	dBi	mV/m	dBμV/m
5	3.5	0.17	−3.00	123	101.77
10	2.8	0.21	−2.05	137	102.72
20	2.5	0.23	−1.53	145	103.24
30	2.4	0.24	−1.38	148	103.39

TABLE XIII

180°-WINDOW CFA PERFORMANCE OVER METALLIC GROUND PLANE.

R_0	$\pm\Delta f$	η	G	E	E
m	kHz	–	dBi	mV/m	dBμV/m
5	3.1	0.13	−1.24	106	100.53
10	2.6	0.15	−3.39	117	101.38
20	2.3	0.17	−2.94	124	101.84
30	2.2	0.17	−2.81	125	101.97

TABLE XIV

360°-WINDOW CFA PERFORMANCE OVER METALLIC GROUND PLANE.

R_0	$\pm\Delta f$	η	G	E	E
m	kHz	–	dBi	mV/m	dBμV/m
5	2.9	0.15	−3.61	114	101.16
10	2.5	0.17	−2.88	124	101.89
20	2.3	0.19	−2.51	130	102.26
30	2.2	0.19	−2.40	131	102.37

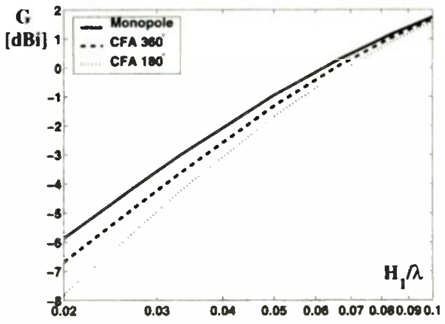

Fig. 15: CFA gain as a function of monopole 1 height H_1/λ, for a disk radius of L_2 = 2.5 m, at the frequency f = 1 MHz and over average ground.

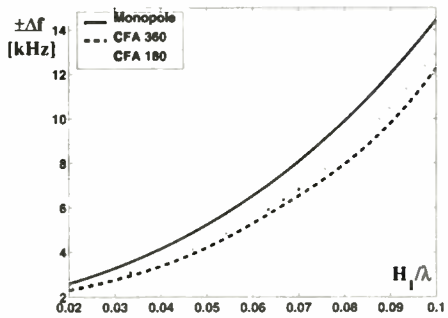

Fig. 16: CFA bandwidth for VSWR = 2 as a function of monopole 1 height H_1/λ, for a disk radius of L_2 = 2.5 m, at the center frequency f = 1 MHz and over average ground.

G. Disk effect

CFA gain and bandwidth have been analyzed as functions of disk radius, L_2, with a constant monopole 1 height of H_1 = 20 m, over average ground, and with tuning coils of merit factor Q_L = 200. A reference monopole of the same height also has been calculated, Figs. 17 and 18, where the deleterious effect of the disk can clearly be appreciated.

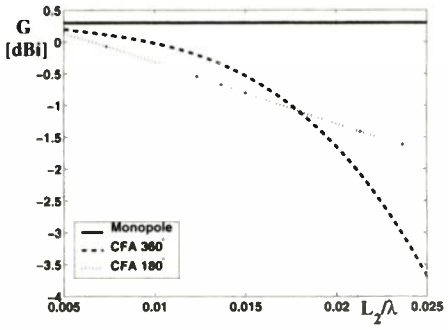

Fig. 17: CFA gain as a function of disk radius L_2/λ for a monopole 1 height of H_1 = 20 m, at the frequency f = 1 MHz and over average ground

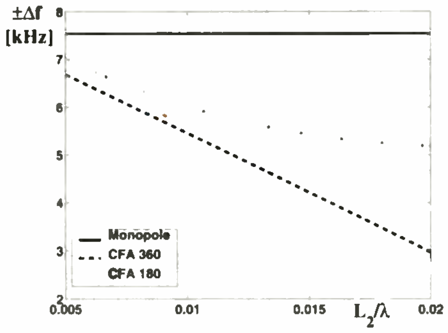

Fig. 18: CFA bandwidth for VSWR = 2 as a function of disk radius L_2/λ for a monopole 1 height of H_1 = 20 m, at the center frequency f = 1 MHz and over average ground.

H. Top-load effect

CFA gain and bandwidth have been analyzed as functions of monopole 1 top-load length, L_1, with a constant monopole 1 height of H_1 = 10 m, over average ground, and with tuning coils of merit factor Q_L = 200. A reference monopole of the same height and top-load also has been calculated.

In Fig. 19, the gain increases as the top-load length is increased for the short monopole and CFA operating in both windows. The disk deleterious effect can clearly be seen, because for a larger top-load the monopole and CFA gains are practically the same.

In Fig. 20, a better bandwidth for the short monopole can be observed in all cases. It seems this technique of top-load increase was adopted after the previous CFA models. The top-load increase was obtained by means of a conical top-load installed to any CFA, as shown in Fig. 3, in order to improve the input impedance, bandwidth and gain, impossible to be achieved by a short barrel alone used as a vertical monopole.

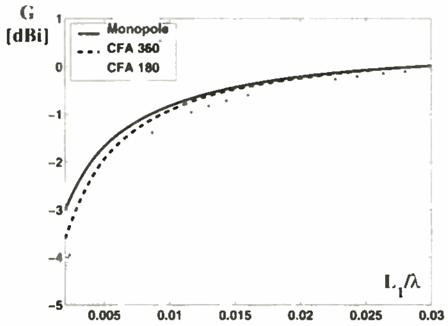

Fig. 19: CFA gain as a function of top-load length L_1/λ for a monopole 1 height of H_1 = 10 m and a disk radius L_2 = 2.5 m, at the center frequency f = 1 MHz and over average ground.

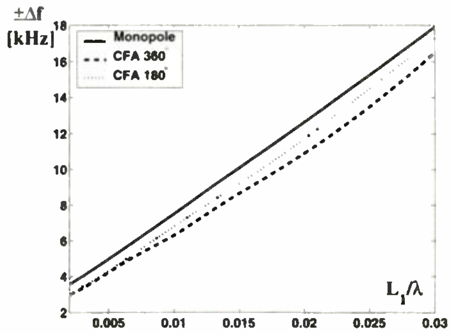

Fig. 20: CFA bandwidth for VSWR = 2 as a function of top-load length L_1/λ for a monopole 1 height of H_1 = 10 m and a disk radius L_2 = 2.5 m, at the center frequency f = 1 MHz and over average ground.

The effect of the top-load cone height ΔH_1 (Fig. 3) is to increase the antenna effective height, so a similar effect could be achieved increasing the monopole 1 height from H_1 to $H_1 + \Delta H_1$ and maintaining the same top-load length L_1.

This is a clear demonstration that a very short antenna always has a sharp frequency behavior and for the CFA this statement also is valid.

MEASUREMENTS

Far-field calculations have been carried out for existing CFAs. Nile Delta Tanta (Egypt) CFA operates at 1161 kHz [13]. This CFA model has been calculated over a flat ground plane with the same available dimensions, in order to compare with the released field strength data.

Fig. 21 shows the measured values compared to a theoretical short monopole, placed over a perfectly conducting artificial ground plane, and a CFA model over wet ground. It can be seen that the Tanta CFA has a field strength according to a short antenna placed over a good artificial ground plane. This antenna was installed over a building with a metallic ground plane laid down in the roof. Metallic straps along the building walls have been installed, connecting the roof ground plane to the actual one at the soil level.

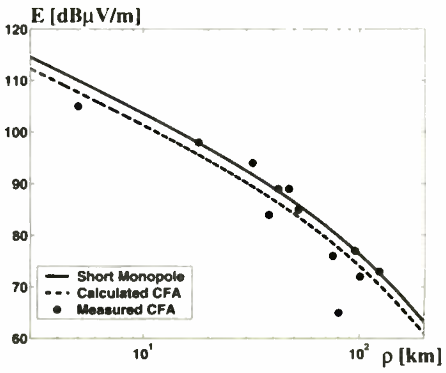

Fig. 21: Measured Tanta CFA field strength as a function of distance ρ compared to a theoretical short monopole and a calculated CFA, on a ground plane of σ = 0.05 S/m and ε_r = 20 for an input power of 30 kW (Tanta CFA was installed on a building roof).

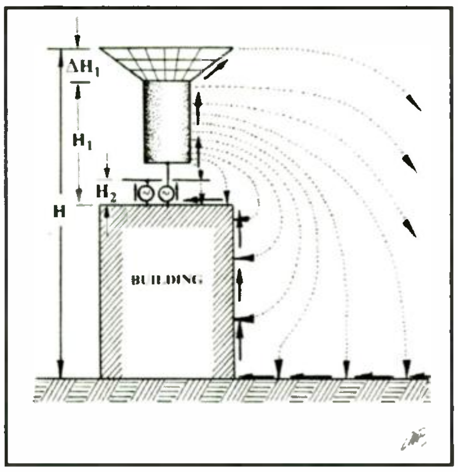

Fig. 22: CFA on a building roof.

This increases the antenna height H and, of course, it increases the efficiency and gain, converting this antenna in a kind of skirted monopole [24], Fig. 22. However, measured field strength values are within the expected values for this kind of short antenna.

Another example is the San Remo experiment at 1188 kHz. This experimental system was developed by Radiotelevisione Italiana (RAI) under the direction of Dr.

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Alberto Fassio, in order to evaluate its performance. Measurements have been made by RAI engineers and technicians under the direction of Luciano Pautasso.

In Fig. 23, RAI field strength measurements are compared to a theoretical CFA model installed over a flat artificial ground plane and average ground. San Remo CFA also was installed on a transmitting building roof and a metallic artificial ground plane was laid down over the roof. Fig. 23 shows lower field strength than the theoretical calculations. In some cases, the measured field strength is close to the average ground theoretical curve, but the actual link was performed over seawater.

Due to low measured field strength values, the top-load of this antenna was increased by means of 16 aluminum tubes, but no increase in field strength was observed due to a very small top-load increase.

In Brazil, two CFAs have been installed — one in São Paulo by Consulting Engineer Sylvio Damiani, PE, intended to be used at 560 kHz; the other in Gaiania by Otavio Emmanuel Lima, PE, intended to be used at 1230 kHz. Personal information from Lima is that these antennas were never operating better than -10 dB compared to a quarter-wave monopole.

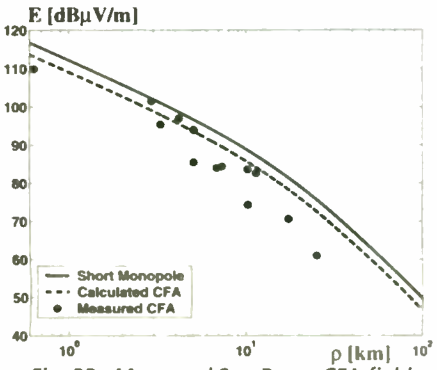

Fig. 23: Measured San Remo CFA field strength as a function of distance ρ compared to a theoretical short monopole and a calculated CFA, on a ground plane of σ = 0.01 S/m and ε_r = 10 for an input power of 2 kW (San Remo CFA was installed on a building roof).

Finally, it was pointed out that a CFA gain improvement is obtained by installing it on a building roof. In the case of very low power installations, as was the case of the short-time CFA experiment performed in Sydney, Australia, an intended 1 kW operation was mandatorily decreased by the authority to 200 W because of neighbor complaints due to interference and disturbances caused to different systems in a crowded area by the radiated AM signal.

CONCLUSIONS

From this analysis, we can conclude the following:

• The disk presence appears to have a deleterious effect, decreasing the CFA performance.

• The CFA performance appears to be a little worse than the reference monopole in gain and bandwidth. The performance increases as either the antenna height or top-loading is increased, in the same way as for any standard short monopole. Also, a simple monopole has a similar or better performance with an easier tuning system.

• If the CFA has the same radiation pattern and near field distribution as any short monopole, then no Poynting Vector Synthesis (PVS) can be seen close to the CFA.

• A CFA gain improvement is obtained installing it on a building roof, in the same manner as for a standard monopole, as is already well known [24].

In this paper we have attempted an exhaustive theoretical analysis of the CFA to evaluate its performance claims. Using the TLM and Method of Moments techniques we have shown that the CFA's efficiency is essentially the same or worse than a standard short monopole. Improved performance of a roof-mounted CFA can be explained by the effective increase in the antenna length due to the ground connection system.

Measurements of experimental antennas in Brazil support these analytical results. Field strength results were always much lower than a quarter wave antenna taken as reference. The lower field strengths are due to the deleterious disk effect, the complex tuning system required by the CFA that introduces additional losses and to an insufficiently sized ground plane. Theoretical calculations of ground installed antennas are giving similar results as the Tanta and San Remo installations even if they are roof-mounted.

Given the greater complexity of the CFA there does not appear to be any benefit in pursuing this approach. A short top-loaded monopole with a proper ground plane could be the best choice in a difficult placement where a standard monopole cannot be used.

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This article was adapted from a paper first presented at the IEEE Broadcast Symposium in Washington, D.C., September 2005. To read it in its entirety, visit www.fi.uba.ar/materias/6654/download/CFAantenna.pdf.

Valentino Trainotti has an electronic engineering degree from the Universidad Tecnologica Nacional in Buenos Aires and completed post-graduate coursework on antenna measurements and geometric theory of diffraction at California State and Ohio State Universities. He is former chief engineer of the CITEFA Antenna & Propagation Division and was on the engineering faculty at the University of Buenos Aires as a part-time full professor of electromagnetic radiation and radiating systems for graduate students. Luis A. Dorado holds an electronic engineering degree from the Universidad Nacional de Tucuman in Argentina. He is an assistant professor at the University of Buenos Aires and is working toward a Ph.D. ■

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by Charles S. "Buc" Fitch, PE

AC: Good For You, Good For Your Gear

Charles S. Fitch is a frequent contributor to Radio World.

When we cruise down the long list of notable business expenses in broadcasting, one that stands out vividly in the present universe of high energy/power costs is air conditioning.

The maintenance of a comfortable and productive working environment year round is our subject here. The basis of AC (or interior climate control) is simple — move calories around.

In this and the following two articles, we divide that caloric movement into the three areas of cooling, heating and ventilation. We'll also look at some case studies, address coolant concerns and visit some sick buildings at the end where things have gone awry.

Additionally, we'll subdivide and differentiate our climate control goals into two: comfort for us and comfort for our equipment.

BE COOL

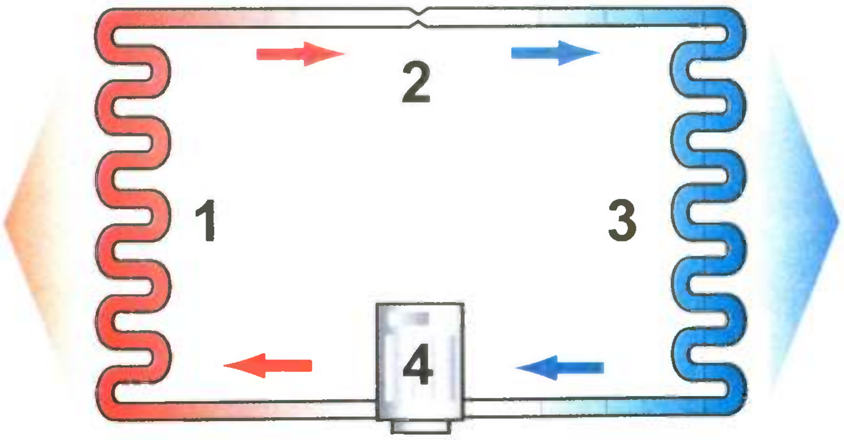
How does cooling AC make us feel comfortable and what factors are our bodies tuned into? As engineers we marvel at the exquisite machine that we are. The body is able to maintain close tolerances under severe challenges. The body's interior temperature is on average 98.6°F, but like a dynamic transistor heat sink, the exterior skin varies drastically in temperature and moisture to maintain that optimal interior comfort zone.

We move off our excess heat by convection, radiation and evaporation. The former is like that heat sink with the higher heat of the body rising along the skin to the head, and in that journey dissipating our heat into the lower ambient temperature air around us. The latter is when our perspiration (radio engineers don't sweat, we just emit) evaporates off the skin and in that action liberates heat from the body.

So on a 100°F day in Dallas, with all of us inside the office and the cooling AC unit struggling outside, what's going on to allow us to be comfortable enough to continue conducting business?

Although there are multiple ways to cool, for the majority of broadcast purposes cooling is most efficiently generated and delivered by gas compression. Expanding gases is the secret of refrigeration, the heart of cooling.

Four major components make up the typical modern cooling system, whether it is a split system (units inside and outside) or a single package unit (everything together in one box on the roof or mounted on the wall or window): the condenser; the evaporator; the air handler system; and the refrigerant gas.



The Refrigeration Cycle: 1) Condensing Coil; 2) Expansion Valve; 3) Evaporator Coil; 4) Compressor

The system is a sealed passage loop for the gas so it's hard to know where to begin our explanation. In deference to my learned first AC instructor, we'll start where he did with the gas arriving at the condenser outside from the treated space (your office) inside the building.

As the gas enters the condenser, it is at a relative low pressure and is fed into a compressor, where it is brought to its highest pressure point. The power expended to accomplish this increased pressure is the largest cost of the cooling operation.

Now think back to high school physics class and Sister Mary Theresa of the Torn Veil. She was introducing you to the mysteries of gases, focusing on Charles Law (no relation to me) and its extensions, which say that when a gas is compressed, its temperature rises. You don't remember that? Trust me then; the temperature does rise.

Next, this very hot gas goes through the condenser coils (these are usually integrated with fins to enhance the heat transfer effect) where the heat calories are liberated into the outside air. A fan, its speed and size scaled to the task, blows air through the coils to help optimize this action. If the gas cools enough, it should turn into a liquid.

This liquid state is piped out of the condenser unit and into the treated space to the evaporator unit. Here this high-pressure liquid encounters an important device, the pressure reducer. This nozzle affair causes the refrigerant to expand quickly in volume and drop drastically in temperature, an adiabatic expansion.

This cool refrigerant now passes through the evaporator coils — sort of the reciprocal in action to the condenser coils outside — where it gives up its cool by absorbing heat calories from the inside air. As the refrigerant temperature rises, it turns back into a gas (evaporates) for its low-pressure trip back to the condenser.

The evaporator also has a properly sized fan and distribution system, the air handler, to move this less-warm air around the finite space and to recirculate that air to progressively lower the air temperature.

Now because we're standing next to the evaporator coils at the moment and enjoying the cool air in the space, let's talk about that air.

Water is critical to life; water in the air, or moisture level, is an important and sensitive factor for us. The warmer the air, the more water vapor it can hold. The cooler the air, the less water it can hold as a vapor.

The actual skin temperature of the evaporator coils can be as low as 35°F in some systems. At this temperature, the air can hold little water and what water there is in the air condenses on the coils. In a typical evaporator/air handler, that water is collected and exited via a "condensate" drain.

In a window air conditioner, the condensate is often collected in a drip pan, and when the water gets high enough, it encounters the edge of the fan blades. A little bend on the edge of each fan blade tosses the water out of the unit. That's the little "ping" heard occasionally on a hot night, which wakes you up in the bedroom when the window unit is running because you think someone is knocking at the front door or throwing pebbles at the window.

To put things together, our AC system has brought down the inside air temperature, which makes it easier for our bodies to liberate our excess heat. Also, it has brought down the humidity, which makes it easier for our bodies to lose more calories by evaporation of perspiration.

COMFORT ZONE

Like an audio processor, AC does have its sweet spot, the point where all adjustments in temperature and humidity feel just right. That point is normally a function of the activity in the space. People expend a different level of heat calories depending on what they're doing. An office at 76°F and 50 percent RH (relative humidity, the proportion of water in the air as a function of temperature) feels a lot more comfortable then a health club at 76°F and 75 percent RH where everyone is sweating up a storm.

In the former case, people are working and expending about 200 BTUs (British Thermal Units) of heat and need only a modest amount of dissipation capability. At the club, they're generating double or more of this and need it cooler and drier to be comfortable.

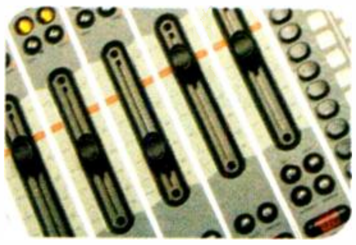
Equipment is in a whole different category than people. Station gear, temperatures and air-conditioning goals are set by a desire to limit deterioration, enhance stability and reliability, and to limit other envi-

SEE HVAC, PAGE 16

Can a broadcast console have a fan club?

"The more I learned about Axia, the more impressed I became with their routing system and consoles, and how well their network topology was designed. We ordered nine studios, and we love it. Our operators keep raving about how easy things are to operate. Even our listeners tell us how good WOR sounds!"

— Thomas R. Ray III, CPBE, Vice President / Corporate Director of Engineering, Buckley Radio



"Axia's Ethernet links are switched connections – no hubs. With guaranteed bandwidth, and some clever clocking mechanisms, latency simply isn't an issue. With regard to cost, we found a significant difference between Axia and the other options we examined. Going with Axia cut our costs by roughly 33%... "

— Ethan Torrey, Chief of Research & Development, Minnesota Public Radio

"We liked Axia consoles so much we installed them in a second studio. Then a third. Then a whole second cluster. And Axia *cost about half* what some companies wanted us to spend. My colleagues are so impressed, they want Axia consoles in their stations, too!"

— Jorge Garza, Chief Engineer Univision Radio, McAllen, Texas

"I've worked with lots of equipment in the past 30 years, and Axia is by far the easiest system to install and get up to speed with. There are just a few cables instead of hundreds; the entire installation – with testing – took just one week."

— Rudy Agus, Chief Engineer, Hi-Favor Broadcasting Los Angeles, California

"The announcers tell us how much they love working with the Axia consoles... It's great to be able to setup and save multiple configurations that can be recalled at a moment's notice. I don't know why we hadn't gone this route earlier. Where we're installing new equipment, we're onboard with Axia."

— Owen Martin, Director of Engineering, Newcap Radio, Alberta, Canada

"The jocks took to the new Axia consoles like fish to water. Show Profiles are their favorite part, because they can all have custom board set-ups. Since the first studio was installed, we've added a new production and interview studio, and we plan on building three more studios. It'll be all Axia, all the way to the transmitter."

— Marc Johnson, Chief Engineer, WEGL-FM Auburn University, Auburn, Alabama

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CONTINUED FROM PAGE 14

ronmental factors such as dust around high-voltage equipment. Again the goal is to find that sweet spot but in this case it is cost versus beneficial effect.

A typical state-of-the-art NRSC FM transmitter room might be very happy between 55°F and 100°F with the RH kept under 60 percent. A computer-based HDFM transmitter might not be happy much past 80°F on the high end.

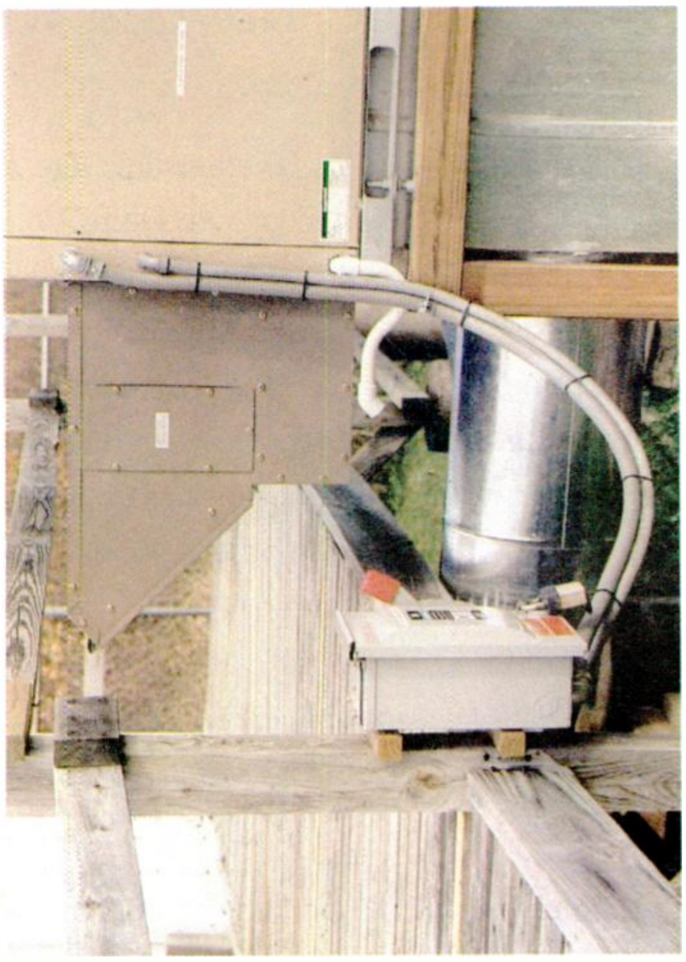
Your computer room with its automation, business and file-serving computers and a zillion hard drives might go berserk if not kept exactly at 65°F and 40 percent RH with both dry and electrostatic dust air cleaners.

Up to this point we've been focused on cooling. Let's reverse this and look at cooling's mirror twin: heating.

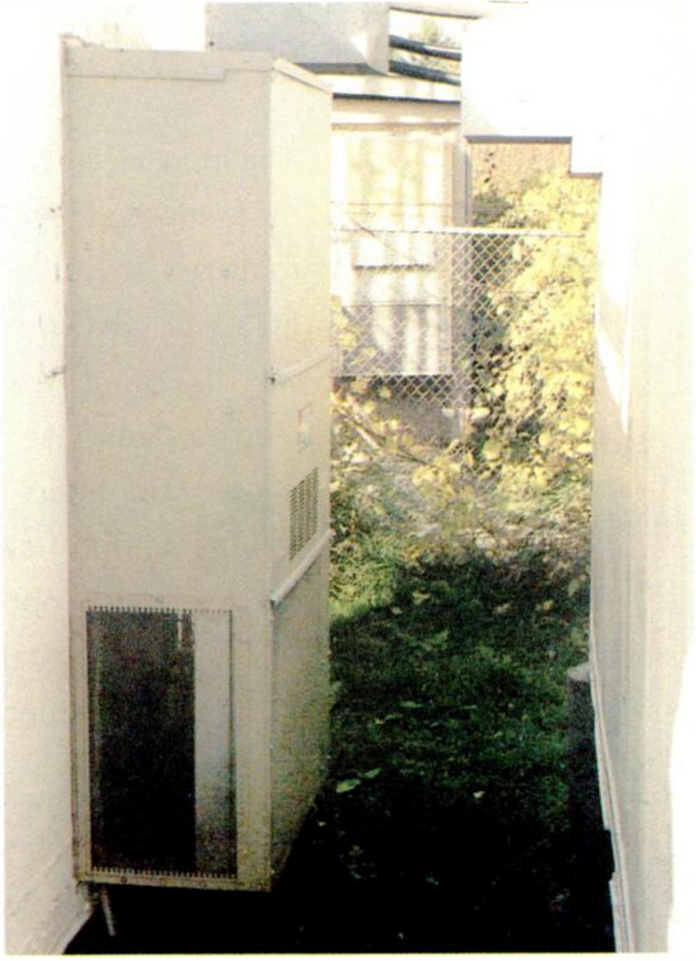
During my young engineering training I noted the speed of outside construction starts to slow down as the temperature goes down. Often when the weather is really cold and depressing, even though people are there and expending effort, progress stops. Sometimes if everyone is miserable enough, things actually start going backwards.

At that point errors come into play. Quality of work is non-existent. Materials and tools just don't go. Motivation vaporizes. Come spring or better weather, everything has to be done over again.

The cold may not be as dramatic as this in your office but temperature does play a large role in how productive activities are in those hallowed halls.



Outdoor Condenser Unit with Electrical Disconnect



Bard Wall-Mount Air Conditioner Installed on Transmitter Container

CHILLY PERCEPTION

Cold is recognized in two ways: perceived cold, the way you feel; and real cold, as read on the thermometer. Let's address perceived cold first.

Earlier we talked about the three ways we can move calories around in our environment: convection, radiation and evaporation. We focused on convection and evaporation in the cooling section, as these two are most involved in the cooling process. Radiation cooling or heating is where temperature is conveyed directly, such as the heat of the sun felt on your skin at the beach.

Similarly, although the cold outside is brought through the walls or windowpanes by convection, that cold radiates from those loci. From that cold radiation, we perceive that it's cold and sometimes we feel that it is colder than the thermometer would otherwise indicate. This effect is exacerbated when you feel warm on one side of your body and cold on the other. Think about how cold you feel when just your feet are cold.

Similarly, air movement such as drafts from nearby vents in the AC system, while warm or warmer than the ambient air, can be perceived as cold due to convection effect. The faster movement of air over the skin increases the liberation of the body's warmth making you feel cold. Doesn't this sound a bit like "wind chill"?

The core of a good system design is to keep the body from making "I am hot/cold" signals. On a practical level, most often you'll find the system supply vents aligned with windows and doors, which are prime locations of cold in winter and heat in summer. Having vents in these areas offsets this circumstance and evens out the room temperature. Return vents are near the interior of the space such that air with the appropriate hot or cold is drawn across the occupied area in an effective and efficient manner.

When possible in a purpose-designed space, vents are located between personnel positions to avoid direct drafts onto these folks.

Making heat falls generally into three techniques: electric, fossil fuel and refrigeration.

Refrigeration? Earlier we talked about moving calories around where cooling transfers the heat calories from the inside space into the outside air. Refrigeration also can move heat calories from outside into the inside air. In simple terms, the cooling cycle is reversed and your system becomes a "heat pump."

Even on a cold day in the 30s, there are still a handful of heat calories in the air. Below this point, on a practical basis, the overall efficiency of a heat pump is insufficient unless you have no other heat source. Usually strip electric heaters either augment or take over heat production.

Earlier we talked about drafts and how heat pumps are big draft makers. If our target goal is 68°F for a room temperature and the temp outside is 35°F, the vent temperature into the treated space may be as low as 72°F. (Contrast this with 85°F to as high as 140°F or so typical vent temperature for an oil or gas hot air blow system.)

Depending on many factors, and even if all are working for you, it will take a long time to bring the space temperature up to 68°F. Further it may be impossible to maintain that 68°F level if the heat loss for the structure is too high with just 72°F heating. To be efficient at all, most heat pumps move a tremendous amount of air through the space, and with this extraordinary air movement at near-ambient temperatures comes drafts and the feeling of cold.

HEALTHY HEAT

High heat is the kiss of death for equipment. If you allow extreme heat, that's probably "gearocide," a horrible crime against silicon.

As mentioned in the cooling section, different types of broadcast equipment have different temperature limitations. Most transmitters are specified to meet their performance guarantees without jeopardy up

SEE HVAC, PAGE 24

JUST ENOUGH TEST

Is your bulky bench analyzer more test than you use and more weight than you want?

Sophisticated Minstruments from NTI give you just enough test capability, plus functions not even available on their larger siblings... and these flexible instruments fit in the palm of your hand

ML1 Minilyzer
Analog Audio Analyzer

The ML1 is a full function high performance audio analyzer and signal monitor that fits in the palm of your hand. The comprehensive feature set includes standard measurements of level, frequency and THD+N, but also VU+PPM meter mode, scope mode, a 1/3 octave spectrum analyzer and the ability to acquire, measure and display external sweeps of frequency response generated by the MR1 or other external generator.

With the addition of the optional MiniSPL measurement microphone, the ML1 also functions as a Sound Pressure Level Meter and 1/3 octave room and system analyzer. Add the optional MiniLINK USB computer interface and Windows-based software and you may store measurements, including sweeps, on the instrument for download to your PC, as well as send commands and display real time results to and from the analyzer.

- Measure Level, Frequency, Polarity
- THD+N and individual harmonic measurements k2→k5
- VU + PPM meter/monitor
- 1/3 octave spectrum analyzer
- Frequency/time sweeps
- Scope mode
- Measure signal balance error
- Selectable units for level measurements

DL1 Digilyzer
Digital Audio Analyzer

With all the power and digital audio measurement functions of more expensive instruments, the DL1 analyzes and measures both the digital carrier signal (AES/EBU, SPDIF or ADAT) as well as the embedded audio. In addition, the DL1 functions as a smart monitor and meter for tracking down signals around the studio. Plugged into either an analog or digital signal line, it automatically detects and measures digital signals or informs if you are on an analog line. In addition to customary audio, carrier and status bit measurements, the DL1 also includes a sophisticated event logging capability.

- AES/EBU, SPDIF, ADAT signals
- 32k to 96k digital sample rates
- Measure digital carrier level, frequency
- Status/User bits
- Event logging
- Bit statistics
- VU + PPM level meter for the embedded audio
- Monitor DA converter and headphone/speaker amp

NEW! AL1 Acoustilyzer
Acoustics & Intelligibility analyzer

The AL1 Acoustilyzer is the newest member of the Minstruments family, featuring extensive acoustical measurement capabilities as well as core analog audio electrical measurements such as level, frequency and THD+N. With both true RTA and high resolution FFT capability, the AL1 also measures delay and reverberation times. With the optional STI-PA Speech Intelligibility function, rapid and convenient standardized "one-number" intelligibility measurements may be made on all types of sound systems, from venue sound reinforcement to regulated "life and safety" audio systems.

- Real Time Analyzer
- Reverb Time (RT60)
- High resolution FFT with zoom
- Optional STI-PA Speech Intelligibility function
- THD+N, RMS Level, Polarity

MR1 Minirator
Analog Audio Generator

The MR1 Minirator is the popular behind-the-scenes star of hundreds of live performances, remotes and broadcast feeds. The pocket-sized analog generator includes a comprehensive set of audio test signals, including sweep and polarity signals which work in conjunction with the ML1 Minilyzer.

- Sine and square waves
- Pink & white noise
- Polarity test signal
- Stepped sweep for response plots
- Balanced and unbalanced outputs

MiniSPL
Measurement Microphone

The precision MiniSPL measurement microphone (required for the AL1 Acoustilyzer and optional for the ML1 Minilyzer) is a precision reference mic for acoustics measurements, allowing dBSPL, spectrum and other acoustical measurements to be made directly.

- 1/2" precision measurement microphone
- Self powered with automatic on/off
- Omni-directional reference microphone for acoustical measurements
- Required for the Acoustilyzer; optional for the Minilyzer

MiniLink USB Interface
and PC software

Add the MiniLINK USB interface and Windows software to any ML1 or DL1 analyzer to add both display and storage of measurement results to the PC and control from the PC. Individual measurements and sweeps are captured and stored on the instrument and may be uploaded to the PC. When connected to the PC the analyzer is powered via the USB interface to conserve battery power. Another feature of MiniLINK is instant online firmware updates and feature additions from the NTI web site via the USB interface and your internet-connected PC.

- USB interface fits any ML1 or DL1
- Powers analyzer via USB when connected
- Enables data storage in analyzer for later upload to PC
- Display real time measurements and plots on the PC
- Control the analyzer from the PC
- Firmware updates via PC
- MiniLINK USB interface is standard

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Stype

CONTINUED FROM PAGE 1

project is anticipated.

Experience, creativity and diligence are necessary tools for the effective consulting engineer. Roy Stype is senior engineer in the consulting firm of Carl E. Smith Consulting Engineers, a division of Warmus and Associates Inc. in Bath, Ohio. Roy has been with the firm since 1978. He received his BSEE from Ohio Northern University and has been a ham operator since 1967.

What is your background and how did you become involved in radio?

I first became interested in electronics in junior high when a teacher who was a ham started a club and license classes for the students. Although this ham club ultimately died, I was bitten and got my novice ham license at the age of 13 through classes offered at the nearby high school. After my novice lapsed after one year, I ultimately obtained an advanced class ham license at age 14 in 1968, which I have held continuously since that time.

Having been bitten by the radio bug, I followed that by taking a correspondence course from the Cleveland Institute of Electronics and obtained my First Class Radiotelephone license in 1969 at the age of 15. At about the same time, I became involved as an "engineer" at "WHSV," the intercom station at Wooster High School.

This high school intercom station, along with the small locally-owned AM/FM combo in Wooster, Ohio was quite a training ground for radio talent in the late '60s and early '70s, as three or four of us ultimately went on to have active careers in broadcasting. This includes one person who went almost directly from high school to CKLW, followed by a long career as a news anchor with both ABC and Mutual and his brother who is still a top morning talent in a major market and another who was, the last I heard, a major-market TV news director.

My first real job in broadcasting was during the summer of 1970, when I worked part time at WIMA(AM-FM) in Lima, Ohio as a part-time engineer doing maintenance and pulling transmitter babysitting shifts while taking summer classes at Ohio Northern University. During my senior year in high school, I also did some volunteer work at WCWS(FM) at the College of Wooster.

After graduating from high school, I enrolled at Ohio Northern University majoring in electrical engineering and chemistry. After being away from radio for several years, I got back into the business in 1975, doing weekend air shifts at WKTN(FM) in Kenton, Ohio and working weekend transmitter watch shifts at WIMA. I ultimately took a hiatus from college to become the full-time assistant chief engineer at WIMA, but returned to complete my BSEE in 1978 while still working full time. After graduation in 1978, I was transferred to co-owned WAAM(AM) in Ann Arbor, Mich., as chief — and only — engineer of a seven-tower directional AM array.

After less than three months in Ann Arbor, I was hired by Carl Smith and have been on the same job for almost 28 years.

Phasor and Transmitter Room at WTMJ, Milwaukee

Just two years later, I was one of the principals who purchased the consulting business from Carl and continue to operate it today. Since the acquisition of the consulting business in late 1980, I have served as the corporate vice president and manager of the consulting division of the company. I sort of came full circle from taking a correspondence course from CIE, which Carl founded, to obtain my first phone, to being one of the principals in the company that purchased his consulting business several years later.

What was it like working with Carl E. Smith?

It was quite interesting to work with Carl and I have the benefit of learning from his experience dating back to the 1930s. While being from different generations, we didn't always agree on how to tackle a project. I feel privileged to have had the opportunity to work with and learn from one of the premier engineers in our business.

Although I worked for Carl for 2-1/2 years until we purchased the consulting business from him at the end of 1980, I didn't work directly with him very often. This is because he was almost 80 by that time and had very little direct involvement with the consulting end of the business. He was more directly involved in the Part 15 and EMI testing portion of the business and was still devoting a good bit of time to the Cleveland Institute of Electronics, which he no longer owned but was still actively involved with as a board member.

The Smith Electronics Building in Brecksville, Ohio, was much like a radio museum and contained either prototypes or actual working copies of many of his devices and creations. Among these was the original servo analog pattern plotter, which was used to generate the thousands of AM directional patterns that were cataloged in several of his books.

The property also included a working antenna test range as well as scale models of many of the antennas that had been developed using this test range. Among them was a 1/3-scale model of the CBM/CBF sectionalized antenna in Montreal. By shorting over the sectionalized insulators and adding a 1100 kHz reject filter, we were able to use this sample antenna quite successfully on the 160-meter ham band and scored quite well in at least one 160-meter contest.

It was on this site that we later installed a UHF-TV station on a 50 kW AM tower with what was the only quarter-wave isolation stub I have ever seen for WR-1150 rectangular waveguide to isolate the waveguide across the AM base insulator.

What was your first big project as a consultant?

There were really several. One of the first was to construct a totally new studio complex for a small FM station in northwest Ohio. This is something I haven't done in years and really miss, but studio technology has changed so much over the last 25 years. I'm not sure I'd even know where to start any more.

I was also involved in several AM rebuilds and tune-ups, which were not only a lot of fun but quite challenging and helped me greatly increase my practical experience with AM directional arrays. I also served as lecturer for the NAB's AM Directional Antenna Seminar for several years.

Is there an AM rebuild or upgrade project that you're particularly proud of?

My personal favorite is probably WTMJ(AM) Milwaukee, Wis., which we took from 5 kW to 50 kW day with four towers and 10 kW night with six towers on 620 kHz. It is an absolutely beautiful facility. It was one of the first, if not the first, former regional station to operate at a power level of 50 kW after the FCC removed the 5 kW cap on the regional channels in 1992.

Another favorite is the recently implemented nighttime operation, WBIX(AM) Natick, Mass. It was a real challenge to diplex the night signal of WBIX into the five-tower array of WAMG(AM) and achieve proper adjustment and stable operation.

The antenna-coupling units are in ocean-going shipping containers that have been modified for this project. The filtering and combining circuitry is in one container at each tower and the antenna-coupling units for each station are in separate containers at each tower. This provides shielding for the antenna-coupling units to maximize isolation between the two stations.

The three-tower 50 kW 1580 kHz array we designed and tuned in Antigua for the VOA is one of the most interesting of my career: the exotic locale combined with the politics and bureaucracy of dealing with a foreign government agency. I saw a lot of history there including colonial-era ruins and an old leper colony while running the proof through the many portions of the island that tourists very seldom get to see.

On Antigua, we had to rent a boat to conduct some off-shore measurements, and the boat's owner and skipper was Dominic Hapsburg, a direct descendant of the Hapsburg royalty, whose assassination started World War I.

SEE STYPE, PAGE 20

Stype

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Your firm has a lot of experience with diplexing and triplexing AM signals. What are the pitfalls of those projects, and are requests for such facilities increasing? Is there a minimum frequency separation that stations should look for when contemplating diplexing?

The necessity to diplex AM arrays has become much greater as zoning and other land use restrictions make it more difficult to obtain the necessary approvals to construct new arrays, particularly in densely populated areas. The most critical issue in designing a diplexed system is attempting to obtain adequate bandwidth for both stations while still achieving adequate isolation between the two or more stations sharing the same antenna systems.

WBIX and WAMG Diplex Site

There isn't really a minimum frequency separation between the two frequencies, but obviously, the farther the better. I normally prefer to see a frequency separation of at least 10 to 15 percent, but it really becomes a tradeoff between frequency separation, bandwidth and cost. A lot of it also is dependent on the characteristics of the antenna system and the associated impedances.

Sometimes there aren't any other available options and it becomes necessary to incur the additional costs and loss of bandwidth to combine two stations that are closer in frequency than normally desirable.

How has the design of phasors changed in order to meet new bandwidth requirements?

Phasor design goals haven't really changed that mush since I started in the business almost 30 years ago. In the 1970s, a lot of effort was put into optimizing feeder system bandwidth for most new installations. Since operating impedance bridges had recently become available, it was accomplished by doing simple things like making sure the system's transmission lines were properly matched.

The biggest difference since then is that much more sophisticated modeling tools and much greater computing capabilities to implement them have become available. I'm sure this will continue to evolve as more and more stations implement HD Radio operation on less desirable antenna systems, including those combined to accommodate multiple stations.

Are there unique systems you've developed over the years to assist in project designs?

The biggest thing we've accomplished as a firm is the development of proprietary computer programs and other techniques to improve efficiency and provide the optimum possible designs and results for our clients while still maintaining the human factor and its associated creativity, instead of being computer operators who just crunch numbers and have no clue as to the actual engineering involved.

We work as a team with everyone in the firm. Perhaps the only real unique feature of our firm is that we've combined almost all aspects of transmitter site and antenna implementation from the original conception and FCC permitting through construction, tuning and licensing using a "turnkey" concept.

WBIX Phasor at WAMG Five-Tower Array

I need to emphasize that as a result, none of these projects are "mine" per se. Instead, they are the result of a cooperative effort by everyone in the firm who was involved either directly or indirectly.

How has the role of the broadcast consultant changed since you began in this business?

In my opinion, the biggest change has been that, except in larger stations and groups, most of our dealings are now with station or licensee management rather than engineering personnel. This appears to result from the fact that many stations no longer have engineering staffs that are empowered to make necessary decisions and handle the task of coordinating the implementation of a major modification to a station's transmitting facilities.

This trend has also made it necessary for our company to handle such projects on a "turnkey" basis, which has become almost a necessity in this day and age.

How has ownership consolidation helped or hindered your job?

It really hasn't appeared to make a lot of difference. We represent several large groups, but also many smaller groups and single-station owners. The most noticeable impact has been the need to prepare engineering studies to document that a proposed acquisition or facilities modification will comply with the FCC's multiple ownership rules, which was seldom necessary prior to their relaxation.

Have you observed a change in station operations since deregulation of station technical standards?

I'm not sure it has really made a major difference. There are still competent, conscientious engineers who do their utmost to keep their stations operating within the applicable technical standards. There are also licensees that will do anything they can to flaunt the rules to their advantage if they think they can get away with it. The only impact of technical deregulation may be that there are a few more stations that fall into the latter category.

What will the consultant of the future have to work with?

Probably some new technologies we haven't even thought of yet. So much of the work of a consulting firm is driven by regulatory and political issues, rather than purely by advances in technology. Thus, while there are likely to be advances in technology, regulatory actions taken by Congress and the FCC will probably have a much greater impact on the job description for a broadcast engineering consultant.

What will the radio station in 2020 be like?

It's hard to tell. If TV as we know it still exists, it is obvious that it will be fully digital by that time. It is still too early to tell how the rollout of terrestrial digital radio will progress and whether it will have fully converted to digital by 2020.

Steve Callahan is the assistant chief engineer for the WBUR Group. ■

by Stephen M. Poole

Crackers, Hackers, Firewalls, Oh My!

Or How to Use Your Laptop, Internet and Nmap Port Scanner to Check for Network Vulnerabilities

Stephen M. Poole is a frequent contributor to Radio World.

When you start exposing critical computer systems to the Internet, they need to be firewalled. But how do you check your firewall to make sure that it's actually blocking everything except what you want the outside world to see?

In a previous article ("How to Protect Broadcast Computers," Feb. 22), I said a server is simply a software program that responds to client requests. A network server does this by listening to one or more port numbers at a given IP address. A firewall is used to reject all unwanted requests. You can tell it to reject everything but port number 1234, for example, and all requests that don't have that port number will be stopped at the firewall.

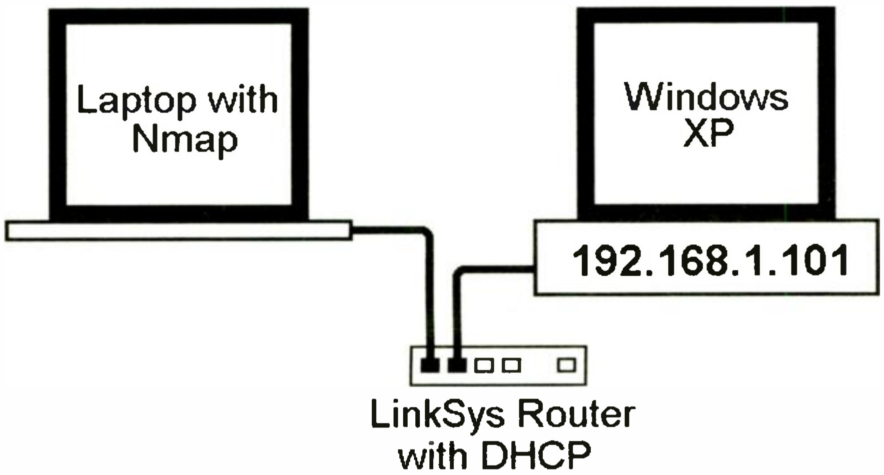

Fig. 1: Using Nmap to Detect Open Ports

To make sure your firewall is working properly, a laptop PC with a network connection is becoming as much a part of the engineer's toolkit as screwdrivers and a soldering iron. In this article, I want to show you how to set up and use a laptop to check your networks for vulnerabilities.

PORT AUTHORITY

The best tool I've found is a little gem called Nmap.

Many services may be running on your networks without your knowledge. Your firewall may be configured incorrectly. To check these things there's no better tool than Nmap, available from *www.insecure.org*.

Don't let the name of the site or the jumbled-looking download page scare you away; this is the best port scanner I've found.

If you're running Linux, Nmap is probably included with your distribution. For Windows, download *nmap-3.9999-setup.exe*, the latest package as of this writing.

Once you've installed it, refer to Fig. 1 for our test rig. The laptop with Nmap and a second machine running Windows XP are connected in a little mini-network, using a router that automatically assigns IP addresses with DHCP. This can be any inexpensive router unit from LinkSys, D-Link or other vendors.

For the following tests, don't connect the router to anything other than the laptop and the XP machine. In particular don't connect it to the Internet, because you must disable the firewalling on both PCs. Under XP, go into the Control Panel, select Security Center and then select Disable Firewall.

We also need the IP address of that XP machine, so run "ipconfig" at a command prompt. If you've never done this, click Start, Run, and then type "cmd" into the box and press Enter. When the command prompt window appears, type in "ipconfig" and press Enter. Look for the line that says "IP Address .... xxx.xxx.xxx.xxx." Write that number down, and then click the "X" button in the upper right corner to close the command prompt window.

Armed with that number, return to your laptop, open a command prompt and enter: nmap xxx.xxx.xxx.xxx, where "xxx.xxx.xxx.xxx" is the IP address you retrieved in the previous step. In Fig. 1, I'm using 192.168.1.101; substitute the correct IP address for your XP machine. In my case, using a typical XP installation with the firewall turned off, I got something like:

```
Interesting Ports on 192.168.1.101:
(The xxxx ports scanned but not
shown below are in state: closed)

PORT      STATE    SERVICE
135/tcp   open     epmap
445/tcp   open     microsoft-ds
```

Your results may vary and you may have other ports opened. In this example, my XP machine is running two services; I'll get to the first one in a moment. In the second line, port 445 is for Microsoft Directory Services, which support file and printer sharing. Older versions of Windows used ports 137, 138 and 139. In any event, having this port open is a definite vulnerability.

It's bad enough to share all your folders — what if someone accesses a file that contains confidential information? But now imagine that port 445 is opened to the Internet. Yes, there have actually been cases of people inadvertently exposing their shared folders and printers to the entire world over the Internet. This has been such a problem that, in fact, most ISPs now filter out ports 137-139 and 445 by default.

But there's another way to look at this and it underscores the aggravation inherent with firewalling. Security and convenience are exact opposites, and keeping a computer secure will often conflict with the way you want to use it. Suppose you really do need to share a folder on your PC. If you set your Windows XP firewall to block port 445, you've undone the sharing; no one will see that folder.

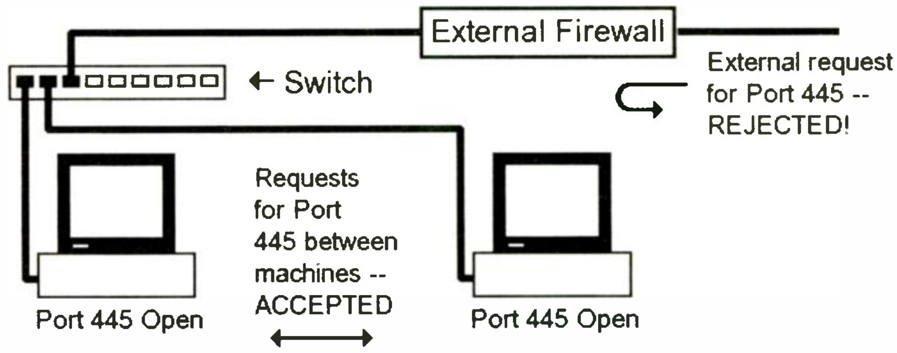

Fig. 2: An Isolated Subnetwork

I said in the previous article there are going to be cases where you have no choice to leave certain services running on certain PCs. The rule is simple: group these machines together and put them on a separate, isolated sub-network ("subnet").

In this case, if you want to share folders, fine; but that automatically implies you're going to need a firewall between that group and anyone outside of that group. You can't depend on the individual Windows' firewalls in each PC to protect you. You will need a separate firewall for the entire group. See Fig. 2.

Now let's take a look at the first port returned by that Nmap scan, port 135, which is DCOM, a common vulnerability.

Nmap may call this something other than DCOM, but what counts is what it is: the Distributed Component Object Model, which by design can permit others on your network to run software remotely on your PC. Giving someone in China access to "My Documents" is bad enough, but this puppy could allow them to execute software on your machine.

Many worms (such as the "Blaster" worm) have been written to exploit this vul-

SEE SECURITY, PAGE 23

CONTINUED FROM PAGE 22

nerability. Another common attack now comes from crackers who attempt to subvert your machine and turn it into a "spambot," a "robot" computer that floods the Internet with unsolicited e-mail.

To be fair, Microsoft has tried to patch the obvious weaknesses with this service. Many ISPs block this port now by default, too. But I still recommend you disable DCOM if at all possible.

Fortunately, with DCOM, you need only click Start, Run and enter "regedit" to start the Windows Registry Editor. But warning: don't change anything else in the registry or you could render Windows unusable. Follow these instructions to the letter.

Once the Registry Editor is running, press F3 to do a search for "EnableDCOM." If this has a "Y" (yes) value, DCOM is active on that PC. If it's "N" (no), DCOM is turned off. You will need to be logged in as Administrator to do this, and if you change the setting you should reboot the machine to ensure it takes effect. You can confirm this with another Nmap scan from the laptop.

There are three possibilities:

• You don't need DCOM at all (most people don't); when you disable it, nothing bad seems to happen. Just leave it disabled to be safe. You should still set the firewall to block that port, though, because some software will try to turn it back on.

• You have a program on your machine that stops working when you set "EnableDCOM" to "N." Enable DCOM, but set the Windows firewall to block port 135 from any incoming network requests.

• Several machines on your network use DCOM to talk among themselves. This was the case with our Prophet network. When I tried to disable or block it, NexGen stopped working. The cure was to isolate these PCs into a separate subnet with an external firewall, as shown in Fig. 2.

This same logic can be applied to any service. Remember, the easiest way to kill an unwanted service is to not install the software that runs it. But that begs the question: What do you do when Nmap reveals a port number you don't recognize? How do you determine who or what has opened that port? This is when you learn that the Internet is your best friend.

Simply do a Google search on the port number and you'd be surprised how much information is available about most common services. Put the string in quotes: for example, "port 135," to force Google to search for that exact string.

Another excellent resource is the Gibson Research Corporation Website, run by Steve Gibson, at *www.grc.com*. In particular, you should try their on-line port scan and information services at *https://www.grc.com/PortDataHelp.htm* (note "https" and not "http"). That link has a box in which you can enter any port number you don't recognize. You'll be taken to a page with information on that port number, along with a button that will scan your machine to see if that particular port is visible from the

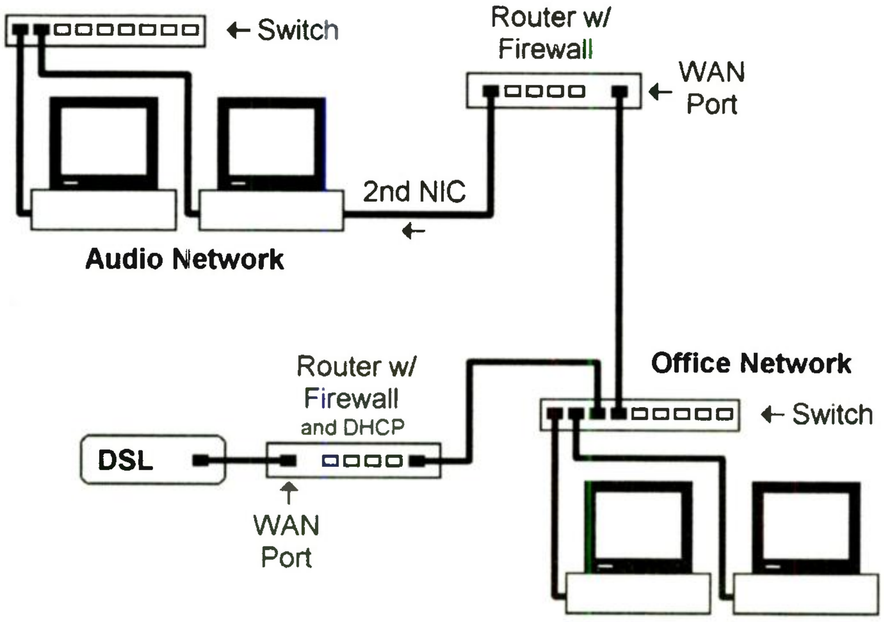

Fig. 3: Granting Access Through a Firewall

Internet on your machine — highly recommended.

USING NMAP ON A REAL-LIFE NETWORK

Now let's look at a typical office network; see Fig. 3. Your network layout may differ and you could certainly have other subnets. I've only shown two, but another good candidate for isolation might be your traffic and billing machines, for obvious reasons. Just consider this a typical setup.

The DSL access has a router and firewall, such as the LinkSys or D-Link units I reference above. These things typically block all incoming ports by default, which is what we want. If we run a server that we want to expose to the Internet, we have to deliberately "map" that port number to the IP address of the server machine inside the building.

We have a static IP address on the DSL connection, and this router sets up Internet access for the rest of the building. It also has a DHCP server to automatically assign IP addresses to the users in the office network. The DSL router is then connected to an Ethernet switch to more easily share the Internet access with everyone on the office network.

We use a second firewall/router to tap into that Internet service to provide access to a second network card in one of the audio workstations. Why use two network cards? This is personal opinion: I like having the audio network on one subnet, with completely separate IP addresses; I then install the second card with an IP address that's part of the office network group.

Do not enable "Internet connection sharing" on the machine with dual cards. That way, people elsewhere on that audio network won't be able to open a browser and download stuff you don't need or want. Plus, having only one machine that's directly exposed to the Internet allows you physically to secure that PC. Put it in a room away from the rest of the staff and limit access to it.

Regardless of the precise setup, your laptop makes a great tool for troubleshooting and checking this setup. I would make Nmap scans in several different locations and look at the results. Using Fig. 3 as an example, your first scans might be on the office network. Plug the laptop into the office Ethernet switch and scan the IP addresses on that network. If you see opened ports you don't expect or understand, investigate as explained above.

But now for the most important scan of all, from outside the building. Take your laptop home and use your personal Internet connection, if you like. When scanning over the Internet, you'll need one additional option on the Nmap command line, "-P0," which tells Nmap to use a special "stealth" mode that does a better job of scanning in this case. Nmap options are case-sensitive; "-p0" isn't the same as "-P0." Also, this particular option uses a zero, and not the letter "O."

For example, if your business' IP address is 212.213.214.215, you'd enter "nmap -P0 212.213.214.215."

What if you have a dynamic IP address? Simply get onto your office network and point a Web browser to *http://www.whatismyip.com* to get the IP address your ISP has assigned to you. The number will change in time, but it should remain valid long enough for you to do an Nmap scan from outside to check for opened ports.

But you have been warned: Go fetch something to read and drink, because the "-P0" option makes the scan take a lot longer. Eventually, you'll get the results, which should be carefully examined. The rule in this case is simple: Unless you are deliberately running a server — UltraVNC, a Web server, something like that — you should see no opened ports on that outside scan. If you do, get busy. Find that server and either firewall it or kill it.

SUMMARY

You have learned how to use Nmap to do a port scan of your various networks. Set up a laptop with Nmap and become familiar with it, because it's a valuable tool when determining when and where to firewall.

So far, I've been concentrating on threats that try to sneak in via any network servers that might be running on your PCs. In my next article, we'll take a look at "Trojan-style" threats — those that could be downloaded and installed without your knowledge, and which will then compromise your networks. We'll use Nmap to test new software, too, to see if it opens unwanted ports.

Stephen M. Poole, CBRE, CBNT is chief engineer for Crawford Broadcasting Corp. in Birmingham, Ala.

Comment on this or any article at rwee@imaspub.com. ■

Emergency Plan

Thanks for the informative article on the advantages of utilizing an STA in times of emergencies ("When Emergency Strikes, File for an STA," Feb. 22).

WLIB(AM) experienced this situation when our #5 DA tower was hit by lightning in November, heavily damaging the building and internal components. We filed immediately and proceeded with repairs. While we were forced to operate on reduced night power, we operated at full day DA power.

The FCC accepted the STA request with a minimum of questions, allowing us to focus on restoration.

Tim Braddock
Assistant Chief Engineer
WBLS(FM)/WLIB(AM)
New York

AM IBOC Observations

Michael, I enjoyed your article ("The AM IBOC Digital Conundrum," Feb. 22). I am the owner of a small 250-watt station. About two years ago, I bought a LPB 1 kW transmitter that sounds great and runs great. At this point, I am wondering if I need to buy a newer transmitter if I convert to IBOC.

I am using a grounded shunt fed tower of 195 feet and the impedance is 50 ohms and bandwidth is exceptional. In my area of southern Indiana there are several group stations [that] will not at this time spend money on IBOC. I would like to maybe be a showcase for the new digital transmission locally and make a little excitement in the process.

As a small broadcaster, I am streaming on the Web to add to our capabilities in reaching more listeners and extend our signal at night. The response has been more than I expected. You can hear us at *www.radio1540.net*.

Back to my original question, do I need another transmitter for IBOC?

Thanks and keep up the great writing about us AMers.

Ralph Turpen
WBNL(AM)
Boonville, Ind.


Radio World
FROM THE TECH EDITOR
The AM IBOC Digital Conundrum
Michael LeClair

I just read through the latest issue, and appreciated the discussion on the AM IBOC digital conundrum. Thank you for just stating the facts instead of taking a side. It should be quite interesting to read about the "interference" testing. I'd also be interested in knowing of any studies related to nighttime IBOC, as everything I've read is mere speculation and not actually science.

Secondly, I am new in broadcast engineering, just out of school and currently working two FMs in a small market. I'd like to learn more about AM. Are there any good resources for learning the ropes on AM antenna pattern and phasor design?

Evan Stanek
Sturgeon Bay, Wis.

Michael, I have several observations regarding your article, the first of which is your rule of thumb that an AM signal is not suitable for consistent listening below 2 mV.

While 2 mV may be below the noise threshold within certain areas (not all) of many large markets, "suitable AM listening" goes well below this level in smaller to mid-size markets where manmade noise is less of an issue.

I would also suggest that for every large radio market, there are dozens of small to mid-size markets that enjoy less noise (or noiseless) listening on the AM band where believe it or not, an analog .5 mV signal is quite listenable where a digital signal, from your own tests, would not be.

I also would add that when a person turns his car radio on as they drive along, they place their volume control at a level at which they can hear the audio of the radio station, not the noise beneath it. Using reasonable audio processing techniques, a station may be able to keep the listener right up until there is no more signal present to deliver the audio to the receiver.

Your initial 2 mV assumption places half of your testing — and therefore your results — at a definite disadvantage, particularly the half concerning analog AM. It also does not properly acknowledge the small to mid-size markets, which actually outnumber the large ones.

I also disagree with the suggestion in parts of your article that the digital signal exists and is not dropping out as it does with analog AM. I would remind you that both the digitally encoded signal and the analog signal are subject to the same RF energy (Carrier) and therefore, to say that the digital signal was audible where the analog signal wasn't seems to me a technical impossibility.

If you lose an AM signal while beneath an underpass, for example, you will lose the digital signal as well. If an overhead power line renders your analog reception to nothing more than a buzz, your digital signal will not lock into your IBOC receiver.

Lastly, it appears your test was conducted on a 1 kW station that had no first-, second- or third-adjacent-channel stations with their IBOC exciter turned on, which would be the case in a nationwide IBOC scenario. Had this been the case, you would have found that both your digital and analog signals would have been further limited in terms of coverage by one or two other such stations.

The question then becomes, "Where is the gain?" To what degree are station owners willing to give up actual coverage for improved audio?

To what degree are station owners willing to give up actual coverage for improved audio?

— Peter Polanco

I am not arguing against IBOC. I believe the idea, as such, is a good one, and I know digital is the way to go in terms of audio quality. However, I see a fatal flaw in the technology as it refers to AM IBOC that its proponents are apparently not willing to acknowledge.

Let's remove politics from technology and find something that will truly move AM into the next century. If that technology turns out to be IBOC, let's bring it in having worked out the obvious kinks and not by grandstanding it.

Peter Polanco
Chief Engineer
Radio Vision Cristiana
Paterson, N.J.

Michael LeClair's piece was interesting indeed. I am an advocate of digital AM, not an adversary; nevertheless, the article didn't divulge a very important data set. Did you go back and measure AM reception at each of the points where you stopped the vehicle — both subjectively and rigorously — when the station was broadcasting in non-IBOC mode?

If you don't do that you are comparing apples to oranges and your conclusions are suspect.

Dr. K. Dean Stephens
Senior Broadcast Engineer
Haleiwa, Hawaii

LeClair

CONTINUED FROM PAGE 3

interference would be unlikely for an inland AM station since it would be impossible to receive at similar distances in the first place.

As an aside, it is interesting to point out that significant analog interference is generated by the 1230 kHz station onto our station, as no attempt has been made by it to limit its occupied bandwidth to less than 12 kHz. We have lived with this interference for many years.

The interference does not appear to affect our new digital reception at all — another way in which digital operation has, in my opinion, bought us an improvement to our marketable coverage area. Another detail of note is that the 1260 kHz station also is operating in HD and neither station affects the digital coverage area of the other.

So there you have the conundrum of AM IBOC digital: This is a system that improves the audio quality and reliable coverage area. But at the same time it does indeed cause audible interference to long-distance analog reception. Even if you stipulate that we are operating in unusual reception conditions, due to the close proximity of the ocean, it is likely that there are many similar situations in other parts of the country. To get the benefits of a digital transmission system, some will have to give up a part of their extended reception area.

Everyone is entitled to their opinion and I won't hesitate to state my own: The improved sound quality and reliable coverage area are well worth the loss of long distance reception that will occur with HD Radio. I would happily trade the limited value of noisy analog service outside the 2 mV contour for high-fidelity audio out to the 0.8 mV contour. I think listeners will too.

I know that many will disagree with me on this one and I invite you to write with your comments to *rwee@imaspub.com*. I'll make every effort to print as many of your comments as I can. ■

HVAC

CONTINUED FROM PAGE 16

to 122°F ambient.

However, going to the other extreme, the greatest concern is not temperature but humidity. As the temperature drops, the air can hold less water and at some point, in moister climates, water will begin to appear on surfaces effecting operation, stability and/or creating rust.

As a practical matter, the low end for temperature should be 55°F, so it's wise to specify some heating capability in the AC systems associated with your broadcast equipment. Besides, even at a lonely transmitter site, when you're there to maintain it in deep winter and the big heater (your main transmitter) is off, you'll appreciate the comfort that healthy heat provides.

The challenge before us in the broadcast arena is to find the intercept point — or at least, the temperature range — of efficacy and efficiency in climate control for both our studio/office complex and for equipment space. Energy allows us the control of our living and working environment for both ourselves and for our vital equipment. Effective environmental control, such as AC, allows us to continue to keep things civilized … at least in the office.

In my next article we'll discuss ventilation and how all those calories get around; some locations where the HVAC went really wrong and put it all together with some case studies.

Charles S. Fitch, W2IPI, is a registered professional consultant engineer, member of the AFCCE, senior member of the SBE, lifetime CPBE with AMD, licensed electrical contractor, former station owner and former director of engineering of WTIC(TV) in Hartford, Conn., and WHSH(TV) in Marlborough, Mass. ■

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The ADCS III provides professional quality 24-bit A/D conversion, along with AES path insertion and interruption functions. The ADCS III may be configured as a standalone A/D converter or to switch AES or stereo analog inputs into another AES stream. The ADCS III is a perfect companion for analog EAS encoders/decoders to be inserted into an AES program stream. The ADCS III is equipped with relay bypass in case power is removed from the unit. The A/D converter may be configured for sample rates of 44.1 or 48kHz (32kHz may be special ordered) or an external word clock from 32 to 96kHz. The ADCS III may be set on a desktop, mounted on a wall or up to three units may be mounted on the optional RA-1, Rack-Able mounting shelf.

CSD-1

The CSD-1 converts a composite stereo signal into discrete left and right balanced outputs. Features include; twin BNC input connectors; multi-turn input level control; twin power connectors allowing up to four units to be driven off of one power transformer; front panel output trimmers; front panel stereo and power LEDs and plug-in Euroblock output connectors. The CSD-1 is powered by a surge protected internal bi-polar 12vdc power supply affording superior headroom and high definition audio. The CSD-1 may be set on a desktop, mounted on a wall or up to four units may be mounted on the optional RA-1, Rack-Able mounting shelf.

DMS-III

The Broadcast Tools AES/EBU Digital Monitor & Switcher III is designed to accept and automatically or manually switch two AES/EBU signal sources when an AES digital error and/or analog silence are detected. Features include: Automatic control function that switches to a back up source upon failure of the main source; Switch functions can be triggered by loss of clock, AES digital error flags, front panel transfer switch, external switch contact and/or the internal analog stereo silence sensor. Additional features: Front panel error status and sample rate LED indicators; front panel headphone jack and level control; balanced stereo monitor output; remote control; removable screw terminals; Plug & Play installation; dipswitch selection of precise time delay from 2 seconds to 85 minutes and restore timing delay from off to 10.2 minutes; defeatable sonalert aural alarm; SPDT status relays; SPDT one-second pulse relay. The DMS III may be set on a desktop, mounted on a wall or as part of the new RA-1, Rack-Able mounting shelf.

RDDA 4x4

The RDDA 4x4 quad-mode AES/EBU digital distribution system provides up to sixteen outputs from a single digital source. The sixteen outputs may be split into four groups, providing four transformer-balanced outputs each from a single source.

The RDDA 4x4 is ideal for distributing AES/EBU signals of sample rates up to 96kHz and/or word clock around your facility without any signal alteration.

The RDDA 4x4 is equipped with four transformer balanced loop-thru inputs with selectable termination and sixteen transformer-balanced outputs with selectable termination. The half rack profile, allows the unit to be set on a desktop, mounted on a wall or as part of the new RA-1, Rack-Able mounting shelf.

ADCS III AES/EBU Analog to Digital Converter & Switcher

CSD-1 Composite Stereo Decoder

DMS III AES/EBU Digital Monitor Switcher III

RDDA 4x4 AES/EBU Digital Distribution System

DAS 8.4 AES/EBU Digital Audio Switcher

DAS 8.4

The Broadcast Tools DAS 8.4 provides AES/EBU digital audio routing/switching of any one of eight AES/EBU inputs to four AES/EBU outputs. The DAS 8.4 may be used in Multicast applications, where an AES enabled EAS device assigned to input eight is routed to all four outputs via a contact closure or serial command. When the alert/test is completed, the DAS 8.4 will return to its previous I/O configuration. The DAS 8.4 may be controlled via front panel switches, contact closures, 5-volt TTL/CMOS logic and/or the multi-drop RS-232 serial port. The front panel is equipped with input and output selection push buttons, output assignment LED's, sample rate LED indicators and a headphone jack with level control. Additional features: 96 KHz AES receiver, a 24-bit D/A converter with analog balanced stereo output, headphone amplifier and 16 x 16 GPIO port. Installation is simplified with plug-in euroblock screw terminals. 1-RU chassis.

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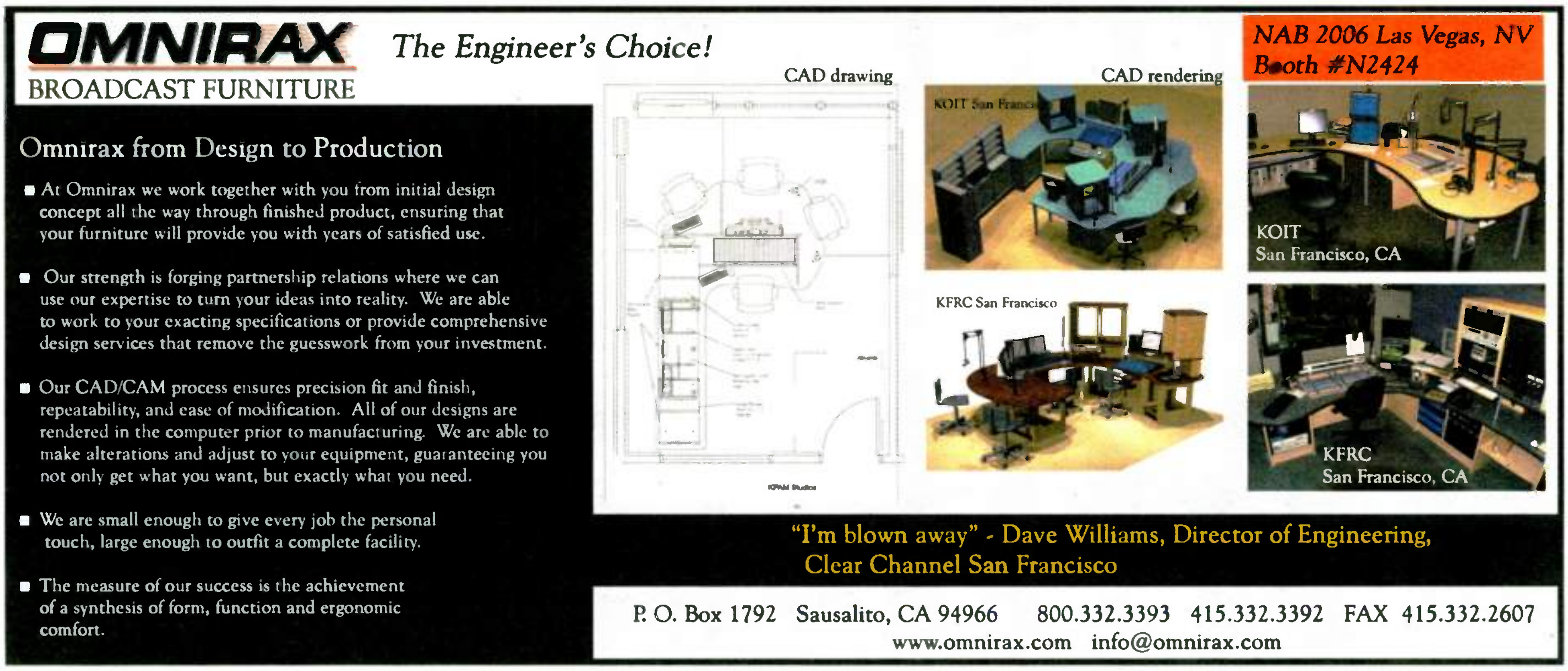

Work Smart to Support the Radio Family

Facing an Increasing Number of Programming Streams, Staff Is Encouraged to Focus on Efficiency

Guy Wire is the pseudonym for a veteran radio broadcast engineer.

A recent RW editorial cited the recent population explosion of radio channels in our industry (March 29). No longer is a radio station only one on-channel AM or FM signal. With the advent of Web streaming and HD, radio facilities all over the country have created new channels and are now facing the challenge of supporting them with additional and alternate content to reach new audiences.

If you work for a multi-station cluster, this probably means that every station in your family has multiplied in number by 3 or 4, or even 5. A six-station cluster could soon be home to almost 30 "signals," if it isn't already.

RISKS AND REWARDS OF NEW GROWTH

Most owners and managers did not anticipate their stations would be burdened by such demands as recently as a year ago. Launching anything new on a different delivery platform that is used by a tiny or virtually non-existent listening audience is fraught with risk and red ink. In the beginning they almost always generate pure expense with little or no income to pay for their development and upkeep. Few make any real profit.

The large conglomerates like Clear Channel and CBS can afford to throw millions of dollars into Web streaming and HD initiatives. They've fully accepted the challenge of taking on the new breed of content delivery competitors like satellite and other Web and wireless streaming technologies.

But smaller groups and stand-alone stations (what few are left) will find it increasingly difficult to compete effectively in this arena. Stations operating with small profit margins will be pressed to adequately fund and develop these new channels into competitive alternatives.

As more consumers discover and start using the new HD channels and streaming choices out there, the size of the "old channel" radio audiences will continue to erode slowly. Smaller stations that do not implement the new platforms are left with defending only their primary turf. They will likely find themselves challenged to keep their product relevant and compelling enough to hold onto existing listeners.

Attracting new listeners will become increasingly difficult as many more new electronic info-tainment options divide the audience into smaller pieces.

Many stations have added Web sites and Web streams, and up until now they have presented a relatively manageable extra workload to create and maintain them. Most of that has been handled by designated Webmasters who typically come out of an IT department.

Web site design is usually farmed out to a Web development company that also serves as the ISP. Regular revisions and additions are posted by a designated promotion or programming person, or a Webmaster in consolidated station groups.

The very large groups like Clear Channel have an entire IT and Web site/Web streaming corporate staff to support this activity for all group stations from the top down.

Setting up the Web stream is usually handled by internal IT and/or engineering support and usually consists of a PC loaded with spot replacement content that encodes the mixed stream to the corporate WAN or internet. Programming and production has to select, program and update the replacement content. Sales and traffic has to provide Web-only commercial content and management to the process.

> **It's time for owners and managers to recognize the need for their engineers, as well as personnel in all departments, to be able to work more efficiently in the new era. They need training and support that have been overlooked in the past.**

That doesn't seem like a lot of extra work after everything is set up and becomes another routine operation. But if there are multiple stations in a cluster to support, that may require more staff to properly handle and execute the additional tasks. For engineering and IT, it's another few "transmitters" that need to be watched and cared for.

A HEAVIER WORKLOAD

Within the past few months, stations that have fired up HD2 formats are suddenly discovering the reality of adding more workload to an already busy staff. Almost every department is affected, including engineering, production, promotions, programming, business and management.

Engineers have been working feverishly behind the scenes at HD stations building the necessary audio, STL and RF chains to transmit the new supplemental HD channels.

The HD consortium has declared that member-station HD2 formats will be commercial-free for two years. Sales, commercial production and traffic folks have a temporary reprieve of sorts before they all get saddled with more stations to sell, produce and schedule. But every other department is being stretched to accommodate the new additions.

Many department heads and managers are hearing from already busy employees about being asked to take on the additional tasks to support these stations within the same theoretical eight-hour workday. If managers expect HD2 stations to pull their weight and be successful, they will have to be properly supported. That may generate some red ink, at least over the near term. Eventually HD2 will require additional staffing. At a minimum, we can all learn how to work smarter right now to keep up.

DÉJÀ VU ALL OVER AGAIN?

The prevailing method used by most HD stations to create and maintain their HD2 formats has taken the path of least resistance: use existing staff with minimal extra hardware or facilities. Virtually all of them are fully automated "radio stations in a box," with content pre-produced and played out of a single PC workstation on the existing LAN.

This approach is a little reminiscent of the early rollout of FM. For years, most FM stations were the automated stepchildren of live AM sister stations that made all the money. This persisted even after FM set penetration covered most households and cars. It wasn't until FM started doing live radio with more appealing formats besides background music and AM simulcasts that it became successful.

Let's hope we've learned our lesson from that experience, but it's only reasonable to expect HD2 formats will continue to be automated until HD Radio sales and set count reaches some kind of reasonable critical mass. Only then will stations risk deploying expensive live talent or syndicated shows on HD2 to bolster their potential for ratings and revenue.

At least there promises to be more variety to choose from with HD2 than early FM offered. And that's only because there are so many more stations on the dial.

NEW AND BETTER TOOLS

This time around, however, we do have the advantage of vastly more efficient tools to use in the creation and execution of radio

SEE GUY WIRE, PAGE 29

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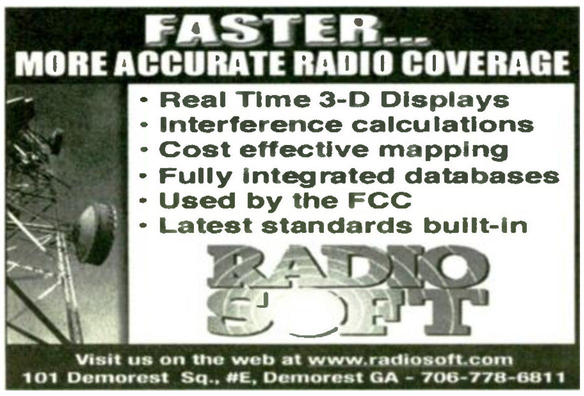

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Guy Wire

CONTINUED FROM PAGE 27

formats Digital storage with PC-based workstations and networks are the engine that drives modern radio. Skilled use of software-based production, voice-tracking, music scheduling, logging and billing functions allow fewer people to do more of the work.

Software and technology are advancing constantly. While the quick-study self-taught folks who rapidly acquire computer-based skills may be okay on their own, many others need and deserve some help. Too many managers just assume that new hires for any given position will have all the developed skill sets they need to "get the job done".

Too many engineering and IT staff are playing a constant game of catch-up. They deserve better.

Most employees need occasional assistance with learning how to work smarter. Too often they are just being asked to do more work that will invariably consume more time.

For staff members to be able to realize their full potential using computer-based tools in their assigned tasks the key is training. Certainly most employees who depend on the PC to perform daily operations could benefit from Microsoft Office or other Office Suite training. Learning and using the key MS Outlook features of Calendar, Scheduling and Task List can help any staffer become better organized and more productive.

Managers also should seriously consider engaging the periodic services of software trainers from the companies that provide the specific platforms used in the facility. Those include the sales support tools, digital editing platforms, the traffic system and the digital storage and automation system being used.

WORKING WITH FINGERS

Most corporate owners have established WAN connections and centralized e-mail servers to their group stations that are carefully supported and protected by corporate IT staffs. E-mail has become the communications vehicle of choice for all business users, with employees at all levels using it from home and on the road to get things done and keep the work moving.

The maturation of networking tools like VPN (Virtual Private Networking), VNC (Virtual Network Computing), PCA (PC Anywhere) and RDC (Remote Desktop Connection for Windows Xp) have enabled employees in all departments to work smarter and more efficiently from anywhere they can find an internet connection.

No longer do engineers usually have to run out to the transmitter or back to the studios after-hours to check equipment status or fix problems. With most equipment now designed for IP networking, they can telecommute and let their eyes and fingers do the heavy lifting.

A LITTLE RESPECT

I know I'm preaching to the choir here, but perhaps the most often overlooked and under-appreciated department in too many radio stations continues to be engineering and IT. These two functions are typically merged and performed by many of the same people except in some of the larger group-owned companies and facilities.

We are indeed the Rodney Dangerfields of the staff who get the least attention and respect. Not much has changed over the years in this regard.

Even more than other staff members, engineers very much need and can benefit from additional training and extended education to keep pace with the torrent of new technologies they are responsible for. The major equipment manufacturers offer training courses on all their major systems at their factories.

MCSE and MCSA courses and certification are certainly desirable but even day-long workshops and eSeminars sponsored by Ziff-Davis and others can provide a wealth of valuable IT knowledge. Staff engineers need to be able to take advantage of these opportunities.

Up until about 20 years ago, station engineers only had to worry about keeping the transmitter plant going along with studio equipment like consoles and tape machines. Since digital technology with PCs and LANs has become integrated with virtually every aspect of station technical operations, there has been a quantum leap in the complexity of today's typical radio infrastructure.

Over the past several years, engineers in most every radio company have been asked to install and maintain more new technology than has appeared in perhaps all of the preceding 20 years. Too many engineering and IT staff are playing a constant game of catch-up. They learn just the basics about a new platform or system during its installation and then need on-the-job training to be able to administer, repair and maintain it.

They deserve better.

VANISHING ENGINEERS

Another consideration most companies have not afforded their engineering staff is the opportunity to hire interns and trainees. Many radio engineers, who started their careers when RF was king and before computers took over, are now retiring or close to it.

Many of us are wondering where the next generation of radio engineers will be coming from. With hardly any broadcast engineering trade schools left, we are faced with having to grow and help train our own replacements.

Many smaller stations have found it necessary to hire contractors and outsource support for most of their technical needs that may have been previously performed by a fulltime engineer. As the pool of available trained and competent radio engineers has been dwindling with every passing year, this appears to be the only reasonable option for them.

But for multistation clusters, relying on contractors or on-call technical support is usually costly and inefficient. Without full-time on-site staff present who can quickly resolve problems involving mission critical systems as they arise, airtime and revenue can be lost and many other staff members can be rendered un-productive for long periods of time.

The demands of HD and other new technologies are putting additional pressure on engineering staff everywhere. Now more than ever, station engineers will play a more important role in determining how well any station will survive, let alone thrive, in the face of ever-increasing competition.

It's time for owners and managers in all radio companies to recognize the need for their engineers, as well as personnel in all departments, to be able to work smarter and more efficiently in the new era. To do that, they need the extra training and support that has too often been overlooked or ignored in the past.

If you're an engineer who agrees with me, forward this article to your GM. Get a conversation going and make some breakthroughs happen. And be sure to let us know how it turns out.

Comment on this or any article. E-mail *rwee@imaspub.com* ■

Blesser

CONTINUED FROM PAGE 30

erty. It is more important to preserve the asset value of the house than to acquire quick cash from the renter.

The same is true for broadcasters. They must preserve the value of their channel, as measured by how gatekeepers make decisions using the composite audio stream, which includes the airtime rented to others for extraneous messages.

COMMERCIALS AS ENTERTAINMENT

Some broadcasters are already viewing themselves as entertainment companies rather than as radio stations renting time to the highest bidder. According to a recent press release, the Creative Services Group at Clear Channel works closely with major advertisers to improve the quality of spots while also reducing their duration and frequency.

Similarly, broadcast engineers should monitor the composite program to avoid excessive loudness, poor audio quality and harsh transitions. Engineers, programmers and advertisers are stakeholders with a joint responsibility for keeping listeners' irritation at a low level. If the irritation factor exceeds some threshold, gates close.

Consider that some Super Bowl viewers were actually watching for the commercials. Rather than viewing spots as a necessary evil, broadcasters can view them as a secondary form of entertainment, engaging listeners, rather than alienating them. Messages need not put pressure on gates to close.

Just as a reckless renter can destroy the value of your home, irresponsible messages can damage your listener audience. Like a latching door, when a gust of window blows gates closed, they stay closed indefinitely. Listeners simply have too many other choices. There is only one first priority: every aspect of a broadcast should put pressure on gates to remain open.

Contact Dr. Barry Blesser with your comments at barryblesser@25-seven.com. ■

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by Barry Blesser

Broadcasters Depend on Open Gates

The Listener's Headspace Is Coveted; What Can Broadcasters, Advertisers Do to Get a Message Through?

Dr. Barry Blesser is director of engineering for 25-Seven Systems.

Messages are everywhere — aural and visual, subtle and in-your-face. As an exercise, catalog the number of political, commercial and manipulative messages that you encounter in your daily life.

Bus surfaces, water coolers, airplane tray tables, gas pumps, school vending machines and bathroom stalls are plastered with messages. Not withstanding governmental regulation, marketing drones still call and fax us at any time of day or night.

Retailers like Kmart put advertisements on the floor to catch your eyes and "storecast" their own radio stations with embedded loudspeakers. To further fill an empty niche, audio engineers are now working on new loudspeaker technology to allow vending machines to beam a narrow radiation pattern to everyone who walks across its path: an automated siren song suggesting that you are thirsty and beckoning you to buy a drink.

Two centuries ago, aural and visual communications were limited to a few letters, infrequent human contact and an occasional local newspaper. During the last century, radio, phonograph and the telephone made aural communications more efficient and readily available; and cinema, television and inexpensive printing provided the same for visual communications.

SENSORY OVERLOAD

Now, with the efficiency of e-mail, computers, electronic displays and computer editing, every nook and cranny of our culture is filled with messages. Compared to the 1930s, today's radio broadcasts, and their supporting advertisers, have an audience that experiences message saturation. In contrast, a 19th-century rural farmer actually welcomed messages brought by a traveling peddler; an occasional message provided social contact.

Listeners today exist in a very different social context: sensory overload.

In our culture, messages are mostly commercial manipulations intended to influence purchasing decisions. In the old Soviet Union, messages were political indoctrinations designed to produce emotional allegiance to an inflexible ideology. And in some theological cultures, messages are religious recitation of a single truth.

Man's proclivity to manipulate the thoughts and behaviors of others is not new, but the technical vehicles for doing so have dramatically increased during the last century.

GATEKEEPERS PROTECT US

As a reaction to message saturation, we create gatekeepers to decide which messages will be allowed into our consciousness. When you sit in your automobile, your gatekeeper decides if your private space will contain music from your personal library, a radio broadcast produced by a particular personality, or the quiet of an internal dialog.

In a modern 21st century culture, we all need gatekeepers to preserve our sanity. Without gatekeepers to control access to our heads, we would be overwhelmed if everyone was allowed to communicate with us. Back when telephones calls cost $1 per minute, there were few such calls. Now with a fixed connection charge and automated dialers, marketing systems can generate millions of calls per hour.

E-mail has no delivery cost once a computer has been provided with an address distribution list. Becoming a podcaster requires only a minimal investment of time, skill and technology. Every wall surface can host an electronic display to provide audio and visual messages 24 hours per day.

In an earlier Last Word article, we examined technology in terms of scarcity and surplus. The concept also applies to messages and headspace.

When technology transformed message density from scarcity to surplus, headspace correspondingly changed from surplus to scarcity. Gatekeepers of scarce headspace now ration this limited resource, providing access only to the highest priority messages. Examples of such technology gatekeepers include spam filters for e-mail, adblock software for Web pages, caller ID for telephone, TiVo for television, the channel selector on a radio, the view hole in a door and so on.

With the exception of hearing, sensory systems have some biological capacity to perform a gatekeeper function. The visual system has a means for controlling access to headspace because the point of gaze is always an active choice: we choose what to look at. Close your eyes, and the visual world is blocked; breath through your mouth, and foul smells disappear.

In contrast, the auditory system has a weak gatekeeper function. Hearing evolved to be always active because that property enhanced survival. Our ancient ancestors needed to hear the sounds of breaking twigs that signaled an approaching predator; a mother needs to hear the cry of her baby regardless of what she is doing. There is no aural analog of eyelids. An aural gatekeeper therefore depends on technology.

We now arrive at the battleground between headspace gatekeepers and message senders. When listeners are captive, as in the waiting lounge at an airport gate, they have limited means for suppressing aural advertising radiating from dozens of televisions. In private homes and automobiles, however, listeners have the means to control access to their headspace.

From this perspective, broadcasters are part of this combat because they depend on the revenue from advertisers who pay for messages, mostly unwanted, only when they penetrate the gatekeepers of a large number of listeners.

Consider this article as an illustration of gatekeeper combat. If readers think that this article has valuable information, they will open their visual gatekeeper to everything on the page, including the accompanying advertisement at the bottom. Conversely, without such an inducement, readers might well ignore everything on the page.

Like broadcasters, I also am part of gatekeeper combat: advertisers are actually paying me to write something to manipulate your gatekeeper. They do not actually care about the content as long as readers open their gates.

Man's proclivity to manipulate the thoughts and behaviors of others is not new, but the technical vehicles for doing so have dramatically increased.

In the same sense, broadcasters must regulate what they transmit such that listeners open their aural gatekeepers for programs, while simultaneously allowing unwanted messages to piggyback through the open channel. This is the proverbial Trojan horse.

What will induce a listener to open his gate? Can advertising messages be designed so that they are experienced as being desirable? These questions have been thrust upon broadcasters simply because the culture has changed. Broadcasters did not create the problem, but neither can they escape it.

The old model of simply selling time to advertisers to use as they see fit may no longer be appropriate. We would never think of renting our house without also monitoring how the renter uses our prop-

SEE BLESSER, PAGE 29

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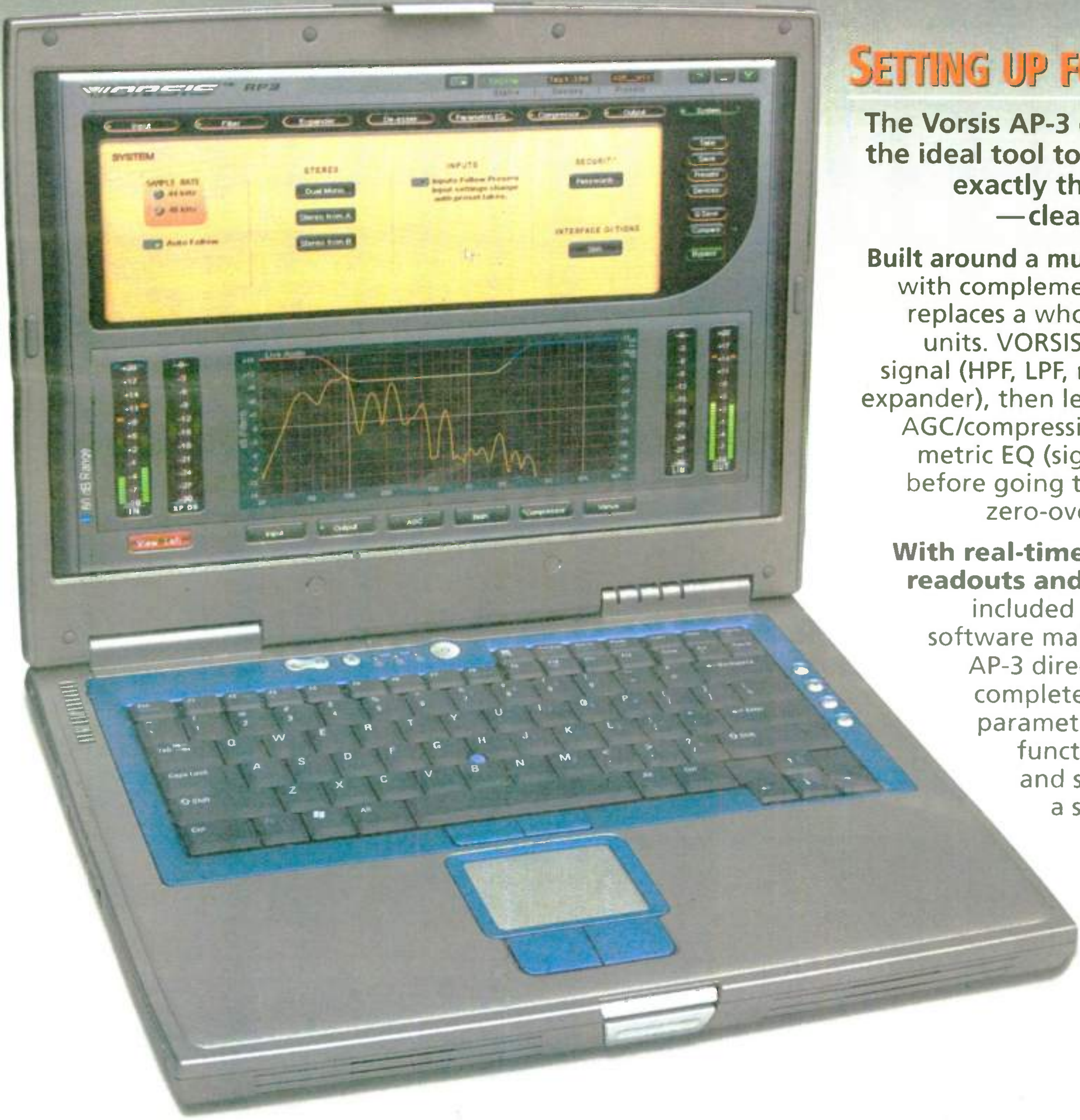

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