Cathay February 2015

www.cathayradio.org

President: George Chong, W6BUR **email:** *W6BUR@comcast.net*

Vice President North: Leonard Tom, *NX6E* **email:** nx6e@hotmail.com

Vice President South: Bill Fong, *W6BBA* - **email:** w6bba@arrl.net

Secretary/Membership: Rodney Yee, *KJ6DZI* - **email:** rodyee2000@yahoo.com

Editor: Rodney Yee, *KJ6DZI* - **email:** rodyee2000@yahoo.com

Treasurer: Vince Chinn aka Mingie, *W6EE* - **email:** vince@vincechinncpa.com

Web Master: Edison Fong – *WB6IQN* - **email:** edison_fong@hotmail.com

Mission: The Cathay Amateur Radio Club is basically an active social club of Ham Radio Operators and their spouses. We support local community requests for HAM emergency communications. Several of us are trained in CPR/ First Aid and are involved with community disaster preparedness.

Monday Night Net Time: 9 PM Local Time/PST, Frequencies: 146.67MHz -600KHz PL85.4 and 442.70 +5MHz PL 173.8. The repeaters are linked only during the CARC Monday night net.

Update: Link to repeater 442.70 is currently not active until further notice.
The CARC Monday night net is the best way to find out the latest club news.

All check-ins are welcome.

Message from the President: George Chong, *W6BUR*

Hello CARC Members and Friends;

I wish to you all an early Happy Chinese New Year. Chinese New Year will occur on Thursday, February 19, 2015.

I know I am repeating myself from the prior newsletter but since this is such an important announcement, I will say it again:

2015 is the **Year of the Ram,** which begins on Thursday, February 19, 2015 and ends on Sunday, February 7, 2016.

If you were born in 1919, 1931, 1943, 1955, 1967, 1979, 1991, 2003, and 2015 you are a Ram person.

Yes, it is time to think about celebrating Chinese New Year which will take place on Thursday, February 19, 2015 and will herald in the year of the Wood Ram.

Folks born in the year of the Ram tend to have a gentle calm nature, polite, reserved, quiet, wise, kind hearted, devoted, and loving. This inner calmness allows their creativity and intelligence to bloom and enables them to work well in a collaborative group effort.

The best mates for Ram folks are Ram, Rabbit, Horse, and Boar. It is best to avoid mates that are Rat, Ox, Dog, and Serpent, and Rooster.

CARC Chinese New Year Luncheon

Let us, CARC members come together and celebrate the Chinese New Year with a luncheon, from 10:30 am – 1 pm on Saturday, February 28, 2015. It will be held at KOME Restaurant in Daly City. Please arrive early to receive your name tag and collection of money for the luncheon. Don’t forget to RSVP: bill.kc6pof@comcast.net

Edison Fong is providing a “boat load” of awesome raffle prizes, so you don’t want to miss out on this event. I wish to express my many thanks to Ed for taking on this huge task on behalf of the CARC. Further CARC luncheon details, raffle prizes and signup information are contained in the latter part of this newsletter.

Featured Tech Article Intro

Last year during the CARC Radio Net, CARC member Bart Lee agreed to write up an article on the use of radar for automobiles that are in use today! This was no trivial task because of the amount of research and background knowledge required to write such an article.

I am very pleased to present for your reading pleasure Bart's very scholarly and well researched article on the development of radar and use of it in today's automobile. I think it is one of the best written articles I have read in a while and it is certainly worthy of national publication, we lucked out by getting to publish it first.

I am sure you will enjoy reading it as much as I did: **"RADAR History and Losing another Ham Band -- 77 GigaHertz -- to Cars! (More Consumer RADAR at Work)" by Bart Lee".**

Once more again, I wish to say: "Many thanks go out to CARC member Bart Lee – K6VK for providing us his wonderful article in this Feb 2015 CARC newsletter and his many contributions to past CARC newsletters".

CARC Final Wrap-up News

Chat sub s'em to all you CARC members! - George W6BUR.

Public Service Announcements

HAM CRAM / HAM Licensing

For upcoming HAM Licensing locations please refer to:
http://www.arrl.org/find-an-amateur-radio-license-exam-session

Auxiliary Communications Service (ACS)

The Auxiliary Communications Service (ACS) was organized by the San Francisco Office of Emergency Services (OES) following the 1989 Loma Prieta Earthquake to support the communications needs of the City and County of San Francisco when responding to emergencies and special events.

The Auxiliary Communications Service holds General Meetings on the third Tuesday of each month at the San Francisco Emergency Operations Center, 1011 Turk Street (between Gough Street and Laguna Street), from 1900 hours to 2100 hours local time. All interested persons are welcome to attend.

The ACS Net begins at 1930 hours (7:30 p.m.) local time each Thursday evening, on the WA6GG repeater at 442.050 MHz, positive offset, tone 127.3 Hz. The purpose of this net is to practice Net Control skills, practice checking in with deployment status in a formal net, and to share information regarding upcoming ACS events. Guests are welcome to check in. ACS Members should perform Net Control duty on a regular basis. On the second Thursday of each month, the net will be conducted on the output frequency of the WA6GG repeater, 442.050 MHz no offset, tone 127.3 Hz, simplex.

For more information, please attend an ACS meeting or check in on a net, or call 415-558-2717.

Upcoming meetings: Tuesday 7pm, Feb 17, 2015
Tuesday 7pm, Mar 17, 2015

Gilbert Gin (KJ6HKD)

Free Disaster Preparedness Classes In Oakland:
http://www.oaklandnet.com/fire/core/index2.html

CORE is a free training program for individuals, neighborhood groups and community-based organizations in Oakland. The underlying premise is that a major disaster will overwhelm first responders, leaving many citizens on their own for the first 72 hours or longer after the emergency.

If you have questions about the recertification process, you may contact the CORE Coordinator at 510-238-6351 or core@oaklandnet.com.

Free Disaster Preparedness Classes In San Francisco – NERT Taught by San Francisco Fire Department

RSVP to sffdnert@sfgov.org or call 415-970-2024 to register.
Visit www.sfgov.org/sffdnert to learn more about the training, other locations, and register on line.

Upcoming Special NERT Events.

February

7th: Intro to NERT Communications Team (NCT) 101-103, 8:30 a.m. - 3:30 p.m., SFFD DOT*

11th: NERT Communications 201: Emergency Messaging 6:30pm-9:30pm, SFFD DOT*

24th: NERT Communications 301: Hands-on buttons & knobs & antennas, 6:30pm-9:30pm, SFFD DOT*

25th: NERT Communications 401: Hands on message passing and Scribing,6:30pm-9:30pm,SFFD DOT* Register

26th: NERT Communications 501: NET Control for NERT staging area, 6:30pm-9:30pm, SFFD DOT*
Prerequisites: NCT 101-401 Register

21st: Neighborhood Coordinator/Leadership College, 8:30am-4:00pm, SFFD DOT*

28th: SFPD ALERT training
Early Pre-Registration Required

*** SFFD DOT is the Division of Training @ 19th Street/Folsom. (enter through yard on 19th and park along back wall) Division of Training classroom is in the 1-story building directly next to the Fire Station on the corner**.

San Francisco Police Department: Auxiliary Law Enforcement Response Team (ALERT)

The Auxiliary Law Enforcement Response Team (ALERT) is a citizen disaster preparedness program designed. The ALERT program is for volunteers 16 years of age or older, who live, work, or attend high school in San Francisco.

Graduates of the San Francisco Police Activities League (P.A.L) Law Enforcement

Cadet Academy are also eligible to join.

ALERT volunteers will first complete the Fire Department's Neighborhood Emergency Response Team (NERT) (www.sfgov.org/sfnert) training and then graduate into an 8 hour Police Department course specifically designed for ALERT team members.

ALERT members will work closely with full-time and/or Reserve Police Officers in the event they are deployed after a disaster. The Basic ALERT volunteer will have no law enforcement powers other than those available to all citizens.

SFPD ALERT Training

The next ALERT training classes have been scheduled for **Saturday, February 28th, 2015**. The classes will be held at the San Francisco Police Academy, in the parking lot bungalow, from 8am-5pm (one hour lunch break).

IMPORTANT- All participants must complete the background interview process in order to be eligible to attend the ALERT training class.

Eligible ALERT participants may register for a training class by contacting the ALERT Program Coordinator, Mark Hernandez, at sfpdalert@sfgov.org, or by telephone at 415-401-4615.

SFPD ALERT Training Drill

All active/trained ALERT members are asked to join us for our next training drill, scheduled for **Saturday April 25, 2015** from 9am-1pm. The drill will be held at the San Francisco Police Academy. Details will be emailed to active ALERT members, prior to the date of the exercise. Participation is not required, but strongly encouraged.

PUBLIC INFORMATIONAL MEETING

An informational meeting will be held at the San Francisco Police Academy, located at 350 Amber Drive, Parking lot bungalows, on **TBD**. All members of the public are welcome. Interested individuals will have their questions about the program answered at the meeting.

For more information on the San Francisco Police Department ALERT Program, email us at sfpdalert@sfgov.org, or call Sergeant Mark Hernandez (SFPD, Ret.), SFPD ALERT Program Coordinator, at (415) 401-4615.

For additional information on the web please refer to:
http://sf-police.org/index.aspx?page=4019

2015 CARC Annual Chinese New Year Luncheon

As for those of you that were able to attend the CARC luncheon last year, we enjoyed seeing each other and yakking it up. As word spread about our successful CARC luncheon get together, those who did not make it told us "We will be there for the next one". This year it will also be a great opportunity to meet up with our newest club members and to renew our old friendships.

The time and Date: 10:30 am - 1:00 pm Saturday February 28, 2015.

Location: KOME Japanese Seafood and Grill
1901 Junipero Serra Blvd.,#A
Daly City, CA 94104
650-992-8600

Parking: There is free parking in the adjacent five story garage structure.

Cost: Special CARC Adult cost will be $22.00 per adult.
Seniors over age 60 pay $21.00
Children Pricing:
Age under 3: Free
Age 3-5: $7.00
Age 6-8: $9.50
Age 9-11: $13.00

These Saturday prices includes: tax (9%), 15% tip, and reserved seating. As you know everything retail seems to goes up in price. This year luncheon, KOME Restaurant kept the same price for the food as last year but now charges for soda, tea and Juice for group luncheons/dinners.

Drink prices not include in the price:
Soda …….$1.99
Hot tea ….$1.25
Juice.…….$2.25

Please note that any beverage other than water (Soda, Tea, Juice, beer, wine, sake) is not included with the price of the luncheon. If you order beverages not covered, you are responsible for paying the additional charges.

For more info please see: www.komebuffet.com (The link appears to be currently down).

Money will be collected at the start of the luncheon, so please have exact change ready! Please put on name tags that will be provided.

Please email Bill Chin (bill.kc6pof@comcast.net) if you are planning to attend the luncheon. Bill has graciously agreed to help us out during this function. We need your name and the names of your guests to make the necessary names tags that you will be required to wear during the luncheon.

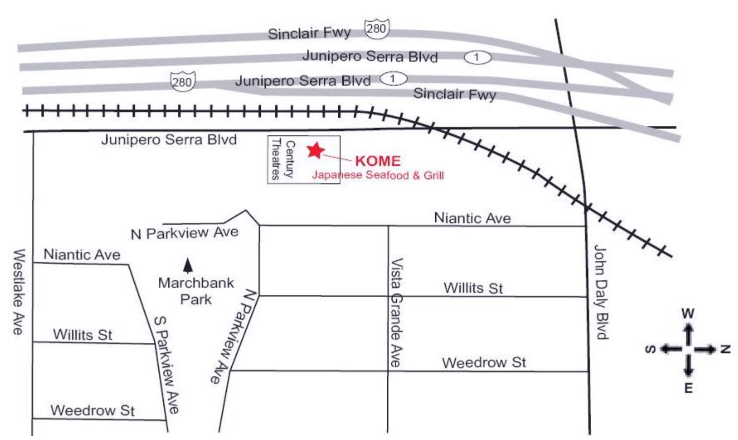
Driving Directions:

* If coming from Hwy 280 Northbound, take the John Daly Blvd/Junipero Serra Blvd exit and continue north on Junipero Serra Blvd and side drive past the Century Theater ticket office.
  After a series of small restaurants on the right hand side there is a 5 story parking garage, the entrance will be about 50 feet past KOME restaurant entrance doors.

* If coming from Hwy 280 Southbound, take the John Daly Blvd/Junipero Serra Blvd exit. After crossing the traffic signal light intersection, in about 500 feet, turn left into the 5 story parking garage structure entrance.

Please refer to the KOME restaurant location map that follows below:

Map To KOME Restaurant



We have reserved the back area room at the KOME restaurant for use of the Cathay Amateur Radio Club. **At the restaurant door please identify yourself as being with the CARC and a KOME hostess will escort you to the back room.** **Please check in with both Vince Chinn aka Mingie W6EE and Hetty WB6SHU so they can check your name off the attendee list and collect the money to pay the restaurant bill.** Hetty WB6SHU will make sure those senior citizens will get their dollar discount. Be aware that the early bird gets the worm, no feeding after 1PM; I hope we won't have to be booted out, hah-hah!

KOME restaurant is an all you can eat Asian buffet style dining offering a large choice of foods. KOME restaurant is where we held our previous Cathay Radio Club Chinese New Year Luncheon and it was a big hit with all the attendees. There is free parking at the adjacent 5 story parking structure. The Daly City Bart train stop is 2 blocks away.

Since KOME restaurant opens its door at 10:30 AM we need to have most of our people "camp" early (kidding) at the door to situate our "hold" of a spot (within the glass partition) at the rear room. **Another reason to arrive early is that the luncheon time (10:30 am-1pm) will quickly slip away while you are getting caught up with the latest news among our fellow club members.** The back room is fairly large is able to accommodate 150 guest. I doubt that our CARC members and friends would completely fill it, so feel free to invite additional guests.

The dining tables as I seem to recall were sort of like outdoor picnic types with individual chairs for seating. One other hint: If you are a great eater and love food, try not to choose any tables where the opposite end is against a wall. I found that it was really hard to maneuver quickly for more goodies!

Now we come to the place in the newsletter that you have all been waiting for:

Grand Prize as requested by members.

A Laptop with 500GB hard drive and 4 GB of memory. Is your old laptop ready for an upgrade? Well this could be it. Running Windows 8.1, Dual core with a LED back lit screen, high resolution camera for Skype , Wireless 802.11n. For many of you, it is time to upgrade your old Windows 95 machine.

Apple iPad mini - No need to describe this. One of the classic tablets with a gorgeous display and has one of the best video and still cameras of any tablet. Great for Apple Facetime.

Leixen VV-898 . The newest full featured dual band mobile. Cover 136 – 174 MHz and 400-470 MHz. Also receives 220 MHz and FM broadcast - Ultra compact. 200 memory channels

Direct frequency input from mic or can be interfaced with a computer for channel programming.

Tecsun PL660 One of the latest portable SW radios around with great audio and one of the very few with SSB. Received great reviews in QST. Full featured clock. Covers AM/FM, LW, SW , air band. Stores up to 2000 memories.

Countycomm GP5/SSB - the latest and best portable hand held HF SSB receiver in the world. Fully software defined using the SiLabs chip. Has software defined product detector. 1000 memories.

Samlex RPS 1220 20 Amps continuous 25 Amp surge . Less than 10mV ripple even at full load. Just what your ham shack needs to power up all your mobile devices.

From the list of the fore-mention raffle prizes provided by our esteemed CARC member; Edison Fong - *WB6IQN* you don't want to miss out on the CARC Chinese New Year Luncheon and Raffle!

Ed has gone and out did himself on both the quality and quantity of lovely raffle prizes for the CARC Chinese New Year Luncheon.

Your Hosts:

George Chong (W6BUR) w6bur@comcast.net	Mingie Chinn (W6EE) vince@vincechinncpa.com	Volunteer - Bill Chin (KC6POF) bill.kc6pof@comcast.net

Featured Tech Article:

RADAR History and Losing another Ham Band -- 77 GigaHertz -- to Cars! (More Consumer RADAR at Work)

By Bart Lee, K6VK, (Fellow of the California Historical Radio Society, holding both FCC Commercial (GROL with RADAR), and Amateur Extra licenses). Copyright Bart Lee, 2014.

As a result of the work of the Indian physicist J.C. Bose more than a century ago,[1] and Nikola Telsa in 1917,[2] and other pioneers, now cars want to talk to each other, it seems, and look out for themselves with microwave RADAR. (See Figures 1, 2 & 3).

The father of microwave engineering is the brilliant Indian multi-discipline scientist: Sir Jagadis Chandra Bose, who worked at up to 60 GHz (5 mm wavelength) in 1895. At the end of the 19th Century,

"… J.C. Bose described to the Royal Institution in London his research carried out in Calcutta at millimeter wavelengths. …Bose used waveguides, horn antennas, dielectric lenses, various polarizers and even semiconductors at frequencies as high as 60 GHz; much of his original equipment is still in existence,… at the Bose Institute in Calcutta." [3]

Tesla also claimed to have worked with milli-meter wavelengths.

The Federal Communications Commission given the cars the 76 - 77 GigaHertz (EHF) ham band. That works out to about a four-millimeter (4 mm) wavelength. "Amateur operation at 76-77 GHz has been suspended till the FCC can determine that interference will not be caused to vehicle radar systems" according to the ARRL. [4] The range from 75 to 110 GHz is known generally as the W -band, and often used by satellites.

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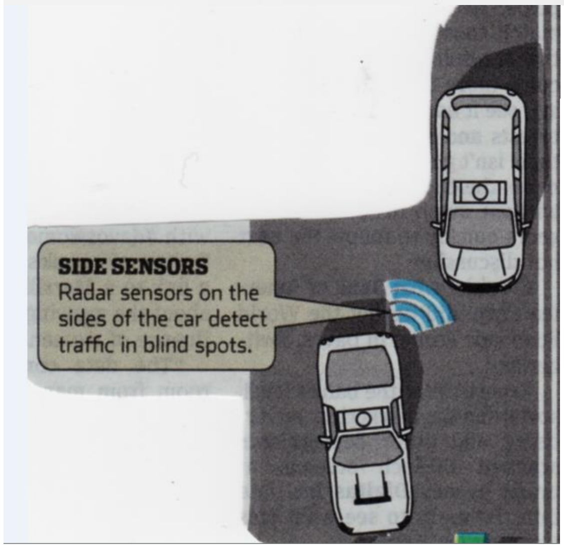
1 D.T. Emerson, *The Work Of Jagadis Chandra Bose: 100 Years Of MM-Wave Research,* National Radio Astronomy Observatory (1998) at www.cv.nrao.edu/ ~demerson/bose /bose.html.See later text at fn. 17, and its reference.
2 W. Bernard Carlson, TESLA -- INVENTOR OF THE ELECTRICAL AGE (2013) at 379 and its note 23; see Tesla text below.
3 Emerson, *supra.*
4 ARRL at www.arrl.org/ frequency-allocations.



Figs. 1, 2 & 3: The illustrations of Sensing Cars are graphics by John Gould for the *Wall Street Journal*; see later footnote below. The cartoon car with the parabolic antenna comes from www.comlawblog.com.

What the FCC has done is suspend amateur radio activity on the 4 mm band to determine if that activity could cause interference with the automotive systems.[5] These systems will operate as Part 15 intentional radiators, but may in the end go up to 100 watts. Google® may become a big player in this range.

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[5] The last time the FCC gave away a ham band it was 220 MHZ. They gave it to UPS for something called compandored AM. UPS never made it work, but hams never got that bottom of the 220 MHz band back either. "ACSSB (amplitude-companded single sideband) is a narrowband modulation method using a single sideband with a pilot tone, allowing an expander in the receiver to restore the amplitude that was severely compressed by the transmitter." http://en.cyclopaedia. net /wiki/ Amplitude- Compandored- Single- Sideband.

It looks like a number of microwave engineers like to experiment at UHF, SHF and EHF, the frequencies of which follow (from Wikipedia):

Ultra high frequency -- UHF -- 300–3000 MHz -- 1 m – 100 mm -- Television broadcasts, Microwave oven, Microwave devices/communications, radio astronomy, mobile phones, wireless LAN, Bluetooth, GPS and two-way radios such as Land Mobile, FRS and GMRS radios, amateur radio.

Super high frequency -- SHF -- 3-30 GHz -- 100 mm – 10 mm -- Radio astronomy, microwave devices/communications, wireless LAN, most modern radars, communications satellites, satellite television broadcasting, DBS, amateur radio.

Extremely high frequency -- EHF -- 30–300 GHz -- 10 mm – 1 mm -- Radio astronomy, high-frequency microwave radio relay, microwave remote sensing, amateur radio, directed-energy weapon, millimeter wave scanner.

The IARU (International Amateur Radio Union) recommends a 4 mm band from 75.5 GHz to 81 GHz in four tranches. This is the U.S allocation for the Amateur Radio Service and the Amateur Satellite Service. So, what if anything was going on in the 77-gigahertz ham band before the FCC shut it down?

And how does one generate a signal in that range?

Today's answer is the MMIC:

"A Monolithic Microwave Integrated Circuit, or MMIC (sometimes pronounced "mimic"), is a type of integrated circuit (IC) device that operates at microwave frequencies (300 MHz to 300 GHz).

These devices typically perform functions such as microwave mixing, power amplification, low-noise amplification, and high frequency switching. Inputs and outputs on MMIC devices are frequently matched to a characteristic impedance of 50 ohms.

This makes them easier to use, as cascading of MMICs does not then require an external matching network. Additionally, most microwave test equipment is designed to operate in a 50-ohm environment.

"MMICs are dimensionally small (from around 1 mm^2 to 10 mm^2) and can be mass produced, which has allowed the proliferation of high-frequency devices such as cellular phones." (From Wikipedia).

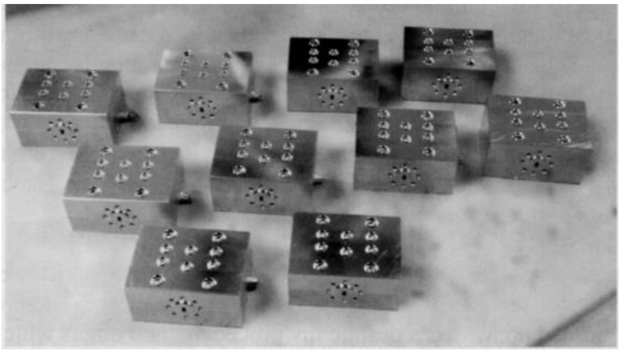
Tom Williams, WA1MBA, makes 4 mm (76 - 80 GHz) MMICs for fun (and he also sells them).[6] He got 25 orders from U.S. hams for the calling frequency of 78.192 GHz and two at 79 GHz, ten from Europe on 76.032 GHz, two from Australia at 80 GHz, three from Japan at 77.750 GHz, and four for EME work (Earth -Moon -Earth) at 77.184 GHz. (A photo of his from *QEX* appears nearby -- it looks like his MMIC assemblies are about 3" by 2" by 1").

There is also considerable 4 mm amateur radio experimentation in the U.K. The U.K. 4 mm Center of Activity is at 75.976 GHz. As in the U.S., both the Amateur Radio Service and the Amateur Satellite Service have access to the band. But since they drive on the wrong side of the road in the U.K., the British hams may not lose this band to cars. This is so because all the signals from any adopted U.S. automotive safety systems could be backward, at best mirror -image. Britain is not likely to make the needed investment to have a U.K. system for its very much smaller population (64 million), although it could sell it to some other countries that also drive on the wrong side of the road. English hams have communicated at a distance of 80 miles on 76 GHz. They used narrow -band FM. The prior English distance record was 63 miles.[7] (Of course, EME distances are longer; that's Earth Moon Earth.) The Australian 76/78 GHz distance record is 139.8 km (87 miles) over a line-of-sight path on both SSB and digital (*WSJT*/JT65C) modes. The current world record of is 252 km.[8]

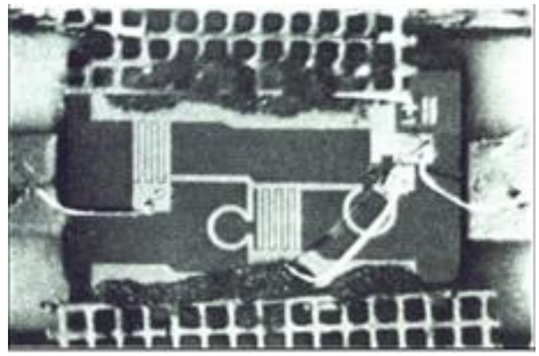
Williams mentions commercial suppliers of LNA MMICs for amateur use (for twice his price) so there are certainly more experimenters out there on 4 mm. He also mentions power up to 300 milliwatts on 4 mm, and frequencies up to 134 GHz from other MMICs.

A microwave history says the first MMIC was put together in 1975, so that's almost 40 years ago, [9] see photo nearby:

[6] Tom Williams, WA1MBA, "78 GHz LNA Wrap-up," *QEX,* March/April, 2014 at page 36.
[7] *CQ* magazine, March/April 2014 at p. 65.
[8] ARRL Letter for June 12, 2014.
[9] "Let's start with the world's first MMIC, which was an amplifier. In 1975, a paper published by Ray Pengelly and James Turner entitled "Monolithic Broadband GaAs F.E.T. Amplifiers" sealed their fate as the inventors of the MMIC." History of MMICs: www. microwaves101. com/ encyclopedia/ historyMMIC.cfm.



Figs. 4 & 5: (Williams caption:) Here is first batch of [MMIC] units after assembly. The first batch proved that we could get good noise figure and what care was needed regarding dressing of the RF ribbon bonds. All These are the "Through Style" Units.



Second iteration of the first MMIC with higher gain and lower noise. From the History of MMICs, cited in the footnotes.

How did we get into microwave technology, including car RADAR, inasmuch as radio started out at long wave frequencies? (Or did it? Hertz worked at two meters wavelength in the 1880s.) According to the National Geospatial Intelligence Agency, in the early days of wireless:

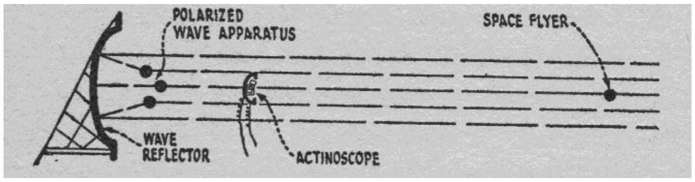
"In 1904 the German engineer, Christian Hulsmeyer obtained a patent for a device capable of detecting ships. This device was demonstrated to the German navy, but failed to arouse interest probably due in part to its very limited range."[10]

A few years later, explaining how to find a miscreant and rogue who has kidnapped his girl and was flying with her to Venus, in the 1911 series in *Modern Electrics*, Hugo Gernsback's Ralph 124C41+ explains:

"A *pulsating polarized ether wave*, if directed on a metal object can be reflected in the same manner as a light-ray is reflected from a bright surface or from a mirror… By manipulating the entire apparatus like a searchlight, waves would be sent over a large area. Sooner or later the waves would strike a space flyer. A small part of the waves would strike the metal body of the flyer, and these waves would be reflected back to the sending apparatus. Here they would fall on the *Actinoscope* (see diagram), which records only reflected waves, not direct ones… From the intensity and the elapsed time of the reflected impulses, the distance between the earth and the flyer can then be accurately and quickly calculated." [11]

[10] BASIC RADAR PRINCIPLES … National Geospatial Intelligence Agency http://msi.nga.mil/MSISiteContent/StaticFiles/NAV_PUBS/RNM/310ch1.pdf. See http://en.wikipedia.org/wiki/Christian_Hülsmeyer for a more thorough discussion of this pioneer.

[11] Gernsback, Hugo, RALPH 124C41+, Boston, 1925 (and University of Nebraska Press reprint) p. 207-08. (An Actinoscope is a device for detection of radiation, invented by one A. Larsen in the 19th century in connection with ultra-violet light. Branly filings coherers may have sometimes been referred to as Actinoscopes at the turn of the last century).



(Fig. 6, Gernsback's diagram).

In 1917, Nikola Tesla envisioned using the reflection of electromagnetic waves to determine the distance and other characteristics of objects. Tesla was the first to see RADAR as an integrated system including a visual cathode ray tube display;[12] Tesla said in a 1917 interview:

"Now we are coming to the method of locating such hidden metal masses as submarines by *electric ray*" replied [Tesla] the electrical wizard. "That is the thing which seems to hold great promises. If we can out a concentrated ray comprising a stream of minute electric charges vibrating electrically at tremendous frequency, say millions of cycles per second, and then intercept this ray, after it has been reflected by a submarine hull for example, and cause this intercepted ray to illuminate a fluorescent screen (similar to the X-ray method) on the same or another ship, then our problem of locating the hidden submarine will have been solved."[13]

His remarks stimulated further European research and development in the 1930s. [14] Did Tesla read RALPH 124C41+ ?

Marconi also foresaw RADAR:

"In some of my tests I have noticed the effects of reflection and deflection of these waves (3-meter waves) by metallic objects miles away. It seems to me that it should be possible to design apparatus by means of which a ship could radiate or project a divergent beam of these rays in any desired direction, which rays, if coming across a metallic object, such as another steamer or ship, would be reflected back to a receiver screened from the local transmitter on the sending ship, and thereby immediately reveal the presence and bearing of the other ship in fog or thick weather." [15]

World War II RADAR provided the impetus to develop microwave technology. The Germans in WW II worked on short range RADAR, the *Freya* system at two meters wavelength.[16] They also had a 10 cm (3 GHz) RADAR with a

[12] Carson, TESLA, *supra* at 379; citing H. Winfield Secor, *infra.* The British later pioneered cathode ray tube displays for the earliest RADAR.
[13] H. Winfield Secor, "Tesla's View on Electricity and the War," *Electrical Experimenter*, August 1917, Vol. 5, No. 4, page 229 at p. 270.
[14] According to Carlson, *supra.*
[15] Proceedings of the Institute of Radio Engineers, Vol. 10, No. 4, August, 1922, p. 231; quoted in J.L. Hornung, RADAR PRIMER, reprint (Chinese printer?) n.d., *c*. 1948, at p. 207; "Thus, in a few words, Marconi outlined what we now know as radar."
[16] Comparable to the 1.5 meter U.S. Navy CXAM and the Army SCR-270, the "Pearl Harbor RADAR."

big parabolic dish, as in Ralph's design of 1911. The Würzburg-Riese (giant) radar (FuMG 65) was technically better in some regards than that of the British. But the Germans made the mistake of siting the 10 cm RADAR on the French Coast. So Britain sent in airborne commandos to steal it, and steal it they did (Operation Biting and the Bruneval Raid).

British RADAR had started out at around 25 MHz in 1936. Power was generated first by silica -envelope tetrode vacuum tubes and then by ceramic tubes. BBC short wave transmissions provided the first test transmissions of this meter - scale "flood" system, the success of which depended on direction finding on the reflections. [17] It was of longer range than German RADAR, and the British coordinated the information from their RADAR better, thus permitting very brave fighter pilots to win the Battle of Britain in the air.[18]

Some novel high power vacuum tubes were developed for RADAR, including the CFT-15-E triode with a directly heated filament. It operated at 600 MHz putting out a 5 KW pulse for airborne RADAR. The following image is the CFT-15-E triode.

(Fig. 7, CFT-15-E triode, from the CHRS collections, photo Bart Lee)

The primary VHF RF generator in airborne and other milli-meter World War Two RADAR was the magnetron, developed by the British. The British perfected

[17] THE BIRTH OF BRITISH RADAR, the memoirs of Arnold 'Skip' Wilkins, OBE, (DEHS and RSGB, 2d ed., 2011) is the best history. Wilkins worked for Sir Robert Watson-Watt, who also wrote about the development of RADAR Britain and who took out the first patent. Watson Watt later, after the war, said to Christian Hülsmeyer: "I am the father of radar, whereas you are its grandfather." (Wikipedia, *supra)*.
[18] The U.S. had explored many RADAR techniques in the 1930s but lacked the technology to generate high power pulses at VHF and higher.

the magnetron in 1939 for generation of higher frequencies, *e.g.*, 10 KW at 10 cm. This later became the engine of the microwave ovens that have since been manufactured by the millions. (A near kilowatt microwave source at about 2.4 GHZ, a shared ham band, is in every one of them -- *QST* once ran a conversion article. See graphic of a relevant hazard sign nearby).

Fig. 8. Enough microwave radiation will turn your eye lenses opaque forever and more than that can cook some (or all) of you. Beware!

Some say we traded transmit / receive switch technology for magnetron technology, but the British simply wanted us to make a whole lot of magnetrons for them so they disclosed it.

But high power magnetron RADAR put its own receivers at risk. The following image is the 721A, a type of radar T/R switch, a major contribution of the U.S to Allied RADAR systems. Pulsed radars using large dish-shaped antennas pointed in the direction of search need to use the same antenna for transmission of high-power RF pulses (megawatts) and then for listening for the faint echoes (microwatts) between pulses. The gas discharge from the transmitted pulse prevents transmission power from entering and damaging the sensitive receiver connected to the same antenna.

What made these RADAR receivers possible was the new klystron. Varian (of Palo Alto) starting in the 1930s made high power vacuum tube klystrons, many of which became TV transmitters after World War Two. Small, low -power klystrons provided the local oscillators in RADAR receivers, running 60 MHz different from the frequency of the pulses and reflections. Inasmuch as the transmitter and the receiver used the same antenna, a switch device (such as the gas discharge tube in a waveguide) was needed to protect the receiver from the transmitter pulse. This was particularly important because a point contact silicon diode acted as the mixer for the return pulse and the local oscillator, and any transmitter power that got through would fry it.

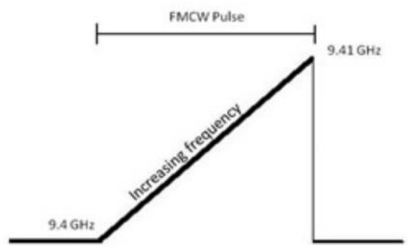
(Fig. 9, a Sylvania 721A, a type of radar T/R switch From the CHRS collections, photo Bart Lee)

AT&T (the national telephone company back in the day) put in a microwave link between New York and Boston in 1947, three decades earlier than the first MMICs. It used special very high frequency vacuum tube circuits. ("Solid state" was then just a baby in Bell Labs). The "lighthouse" microwave tubes followed in the 1950s.

So, microwaves and RADAR have been around for a long time, roughly a century in terms of their beginnings. What *is* very new are consumer applications.

Some new consumer "FM" marine radars can discriminate objects as close as six feet, with the power of a cell phone. Some car RADAR will likely operate on the same principles. This type of "broadband" marine RADAR operates just below 10 GHz -- 3 cm. (Amateurs also operate on 10 GHz. The distances possible are hundreds of miles over water).

"Broadband radar is a generic term for Frequency Modulated Continuous Wave (FMCW), which is a new way to achieve radar signals. The 'Broadband' tag comes from the broad band of frequency it uses to interrogate a target. In fact FMCW compares changes in frequency between the transmitted and received signals to calculate range, instead of the conventional system of timing the interval between outgoing and returning signals. At low power, FMCW radar sends out a long pulse lasting about one thousandth of a second. Conventional radar sends out a short pulse but at very high power." [19]



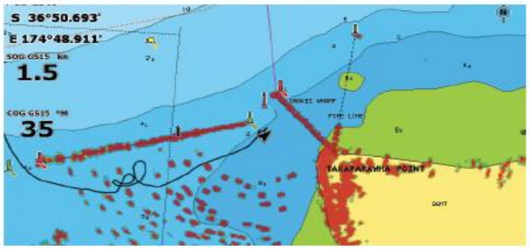
(Fig. 10, a graph of frequency *vs*. time for a FMCW pulse.)

Nearby is a graph of the changing frequency of the FM radar pulse (vertical scale). It goes up in frequency during the time of the pulse (horizontal scale). The reflection comes back at some sent frequency between 9.4 GHz and 9.41 GHz. Inasmuch as the pulse goes up in frequency with time, the initial return reflections at a given frequency, say, 9.405 GHz converts to a distance (speed of light and all that) because the machine knows how long ago it sent that frequency in the frequency-rising pulse and knows what frequency it is sending at the moment of the return reflection, and hence how much time it took to go to the object and return. Close-in objects will always reflect the lower frequencies of the pulse fairly quickly but distant objects will reflect much of the whole frequency range of the long pulse later in the pulse duration.

As the frequency of the low power FM RADAR pulse goes up, here from 9.400 GHz to 9.410 GHz (10 MHz), a simultaneous wide-band receiver can hear a reflection of what was sent earlier and later in the pulse. The closer the received reflection is in frequency to 9.400 GHz, the closer is the reflecting object. This is so because a close object reflects the pulse at the lower frequencies, because that RF energy gets to it first and reflects first, and that earliest returning RF energy is at the lower frequency. By the time the RF energy gets to a more distant object, say 10 miles away, it also has risen to the higher frequency, closer to 9.410 GHz. A reflection that includes that higher frequency has to be more distant and the receiver hears that higher frequency reflection and shows it farther away. Of course such a system rotates virtually or actually, so azimuth appears on the screen showing reflected objects at a distance and at a bearing. A great deal of computational power is needed to make this work, in color with map and chart overlays.

The marine RADAR only displays, it does not steer (yet): [20]

[19] www.rya.org.uk/cruising/ navigation/ Pages/ BroadbandRadar.aspx and its illustration.



The image above shows a boat safely navigating through a vessel mooring field at close range with Broadband 4G Radar.

The same vessel mooring field as seen by eye is incredibly crowded and challenging to navigate through without the aid of radar.

It may be that car RADAR will have to use FMCW for near vehicle detection and to keep power low for safety. As with boats, powerful computational power would be needed to make this work.

So, *what could possibly go wrong*?

The new automotive RADAR and related systems will supposedly keep cars from hitting each other and running into things, according to the *Wall Street Journal*.[21]

The *Wall Street Journal* article goes on to note that such automated car systems will be subject to hacking including capture of control of the cars and trucks using the systems.

The "total information awareness" (to use NSA's phrase) that the vehicles will supposedly enjoy will come from not just the 77 gigs RADAR, but also LIDAR (light detection and ranging), SONAR, video cameras with analytic software and GPS positioning systems.[22]

With this new automotive technology, one day everyone will just get in their cars, tell it where to go and have a beer, relaxing for the ride.

But all new cars are now required to have data recorders: everywhere you go and everything you do (with your car, at least) is recorded. This is so the lawyers can use it against you later, of course.

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[20] www.lowrance.com/ Global/Lowrance/ Documents/ Broadband Radar 4G_3G Essential Guide_3406.pdf and its illustration.

[21] Ucilia Wang, "How Driverless Cars Know How to Drive," *Wall Street Journal*, March 24, 2014, page R4; acknowledging Paul Perrone, Chair of the Road Automated Vehicles Standards Committee of the Society of Automotive Engineers, for her information on RADAR.

[22] Denny Monticelli, AE6C, CHRS, suggests the LIDAR will focus on close -in objects (and people) and the RADAR on more distant vehicles and structures.

The new 4 mm automotive RADAR, and the related sensing technologies, will generate enormous amounts of data, and no doubt it too will be recorded -- digital storage is so cheap these days and getting cheaper.

Soon these cars will also record what signals come from other cars they come near. Then there will be in each car a record of every other car with which it interacted. For this to work, the energy sent out by each car with have to be labeled with a digital identification packet. That packet may actually be the sensing data sent out. So it won't be like old analog RADAR, with just a pulse on a specific frequency. It will likely be a digital data pack so the other car can record who pinged it, and vice versa. Doppler shift can provide velocity and acceleration data.

Then there's the problem of interference. Perhaps each brand or make or style of car and truck will get its own set of frequencies. This would help in identifying other cars in terms of mass and momentum. If spread spectrum techniques can be applied to FMCW operation, then interference issues diminish, as long as all cars operate spread spectrum.

Another possible resolution of the interference problem is a digital filter, so that the primary response is to one's own car's digital ping and its echo.

Just "listening" to other cars' digital signals for safety information (and recording them) is a simpler process because they will not be weak reflected echoes but rather stronger sensing pulses. That's similar to World War Two IFF technology (Identification Friend or Foe): RADAR echoes would be very weak, but the return signal from an interrogated aircraft is quite strong in comparison because it comes from a dedicated transmitter on the right frequency.[23]

Automotive RADAR may well more resemble digital IFF than search modes. But search and find modes (including SONAR and LIDAR) will play a role in accident avoidance with objects (non- metallic, like people) and non - responsive vehicles. These search functions can be short range, but the IFF functions would be longer range, and likely aggregate all responding vehicles for analysis and perhaps display to the driver. It could look something like an air traffic control screen, but with selectable filters, as a Google® heads-up

[23] The first British system for IFF was just a dipole at the meter wavelengths of the early British RADAR, mounted on the target aircraft. A motor system then repetitively shorted ("keyed") the dipole to affect reflections back. Wilkins, *supra*, 61ff. German planes just wagged their wings to signal their nationality when returning home.

display in front of the windshield. A driver could watch his self- driving vehicle thread through obstacles like a boat through a marina.

But the "internet of things" does raise serious hacking issues, especially when the "things" are, for example, fully loaded gasoline tanker trucks moving at 65 miles an hour.

Clever but evil hackers will want to figure out how to spoof a returning sensing echo, say, to make such a truck (or many of them) swerve out of the way of a non-existent but spoofed similar truck, maybe in a tunnel.

Plain old negligence did that in the Oakland's Caldecott tunnel some years ago with horrific effect. Technology will not always be an unmixed blessing.

73 de Bart, K6VK

(Special thanks to Jim Kreuzer, archivist at the Antique Wireless Association in New York for the Tesla text and Ralph 124C41+, and to Denny Montecelli re LIDAR and to Rodney Yee, CARC for editorial assistance) ##