RTT TECHNOLOGY TOPIC
February 2015

Automotive radar

We have reviewed radar technology in two previous technology topics

http://www.rttonline.com/tt/TT2008_003.pdf - radio and radar

http://www.rttonline.com/tt/TT2008_004.pdf - a longer look at radar

This month we are looking at automotive radar at 24 and 26 GHz, 77 GHz, 122 and 244 GHz and the potential impact of emerging automotive radar technologies on 5G research and development and network delivery economics. 77 GHz radar is sometimes described as 79 GHz radar as the band extends from 77 to 81 GHz (4GHz).

https://itunews.itu.int/En/3935-Future-trends-for-automotive-radars-Towards-the-79GHz-band.note.aspx
www.79ghz.eu

The band is in the middle of the E band allocations at 71-76GHz and 81-86GHz proposed for ultra-high bit rate **wide area** radio systems in the US defence sector - see last month's technology topic on military radio development.

http://www.rttonline.com/ttopics/tt2015.html

This suggests that E band between 71 and 86 GHz might be a sweet spot for 5G spectral deployment.

The automotive industry is presently developing intelligent transport communication systems using a modified 802.11 physical layer (802.11p) at 5850 to 5925MHz, above the existing 5 GHz WiFi band.

http://www.nxp.com/campaigns/connected-mobility/applications

E band would however provide significantly more bandwidth and the opportunity to share component and system economies across defence, automotive and mobile broadband markets. The innovative signal processing and frequency and time domain spatial signal analysis used in automotive radar could also be directly translatable to 5G physical layer development.

R and D budgets in the automotive industry are similar in scale to the telecommunications industry – VW on its own spends over $12 billion dollars per year on R and D. An increasing percentage of this budget is being spent on radar and sensing systems which will need to integrate and co-exist with future radio systems.

This implies a parallel need to consider the co-existence of radio networks and cars equipped with multiple radar transceivers.

It therefore makes sense for the automotive radar supply chain and mobile broadband community to work together to explore technology translation opportunities and to mitigate future coexistence issues.

Read on

In our January technology topic we argued the case for E band between 72 and 77 GHz and 81-86 GHZ for 5 G on the basis of channel bandwidth availability (5+5 GHz of spectrum), power (up to 3 watts for user devices) and link budget (2 degree beam width spot beam antennas providing 60 km clear weather range). This would provide the basis for 10 gbps of fixed and mobile connectivity with an ability to scale to large cell sizes to support low cost high mobility stable latency high data rate wide area coverage.

E band offers significantly more bandwidth than 802.11p (5850-5925 MHz) with less onerous adjacent channel requirements and could have the advantage of being a standardized LTE compatible physical layer in a globally standardised band (802.11p comes in three regional flavours).

Economically the spectral positioning of automotive radar (77 to 81GHz) mid-way between the 72-77 and 81-86 GHz bands opens up technology scale and integration opportunities.

Automotive radars use a form of chirp radio in which the transmitted signal moves in frequency continuously across the channel. The frequency difference between the sent and received signal is captured as a 'beat frequency' which is then used to establish the time delay and hence range and movement of the detected object.

Chirp radars are cheaper than pulsed radars and use less power. Chirp waveform 77 GHz automotive radars consume about 2.5 watts and are capable of differentiating objects and their size, speed and direction over a distance of 150 to 200 metres at speeds of up to 160 kmh.

Once the preserve of high end cars, automotive radars are now available as optional extras or as standard equipment on mid-market vehicles for collision avoidance (lower insurance premiums) and are being integrated with laser (LIDAR), ultra sound and imaging systems to move motoring towards a highly managed (safer) more automated experience.

Radar systems have a number of advantages over optical systems - the units can be hidden behind plastic bumpers and can detect non reflective objects (dirty cars!) and work in adverse (foggy) weather. They can point forward, sideways, backwards and can detect speed, distance, direction and elevation (differentiating a bus from a sports car and a pram). More complex systems are presently being designed with up to 11 separate radar transceivers.

24 and 26 GHz systems have met with deployment issues due to the use of this band for weather sensing (24 GHz is the mechanically resonant frequency of water vapour). 122 and 244 GHz are both interesting but challenging in terms of RF component performance. 77 GHz is attractive in that it has plenty of bandwidth (to provide good radar resolution) and is benefiting from substantial component and system level investment.

http://www.bosch-mobility-solutions.com/en/de/_technik/component/CO_PC_DA_Adaptive-Cruise-Control_CO_PC_Driver-Assistance_2434.html?compId=2496

http://www.freescale.com/webapp/sps/site/application.jsp?code=APLADDRAS

This investment is yielding RF component innovation, spatial processing algorithmic innovation and new approaches to smart antenna design, all potentially useful for 5G user and network devices.

The robust but cost effective test regimes used by the automotive industry could also be beneficially applied to help reduce 5G RF test costs – testing the linearity of the sweep waveform for example is a critical parameter.

http://www.electronicsweekly.com/news/design/test-and-measurement/putting-car-radar-technology-test-2014-08/

Conversely military investment in E band radio systems is yielding materials innovation (improved gallium nitride based devices) and network topology innovation (adaptive routing techniques) which can translate across into automotive radar and connected car applications.

It would be particularly intriguing to explore the potential of an integrated network that coupled automotive radar and a spectrally adjacent 10 gbps 5G mobile broadband network if automotive is extended to include anything that moves.

On a first pass it might seem problematic to have 4GHz bandwidth automotive radars centred on 79 GHz coexisting geographically with a 5 + 5GHz bandwidth 5G radio network between 72 and 77 GHz and 81-86 GHz. Interference management however is essentially spatial awareness which in turn can be used to beam form to discriminate between wanted signal energy and unwanted signal energy.

And there is no reason why cars and other moving objects including delivery vehicles, buses, trains and boats and planes cannot function as mobile repeaters and relays. If every Ford in the world had an integrated LTE repeater and or relay, painted black obviously, you would have by default a perfectly adequate global LTE network with virtually non-existent estate management costs.

http://www.rttonline.com/tt/TT2014_001.pdf

Summary- automotive and 5G integration opportunities

Automotive has been an important market for two way and cellular radio from the very start of the industry

http://www.rttonline.com/documents/History_Archive_01v3.pdf

In the context of the contemporary supply chain and network delivery economics of 4G LTE there is an already well established coupling of mobile broadband with emerging connected car applications. Network operators are developing market offers linked to car manufacturers using automotive connectivity, support and safety platforms as a service and value differentiator.

http://www.reuters.com/article/2014/09/29/us-connectedautos-wireless-verizon-comms-idUSKCN0HO25520140929

In the context of the network and supply chain economics of 5G it is reasonable to assume that automotive integration will become progressively more important with the integration of automotive radar being a key part of the integration process.

Many existing safety features such as collision avoidance are stand alone with limited reliance on network connectivity. In the longer term this limits functionality and user value. Using cars as observant machines sharing data in real time with other road users would be a significant step forward but implies a need for wide area high data rate low latency/stable latency networks.

The vehicles themselves can be part of that network. The relay and repeater standards evolving in the Release 12 and 13 standards process should help to take that process forward – part of an internet of moving objects.

There is a school of thought that 5G is not a new physical layer but rather an abstraction of existing and evolved personal, local and wide area radio technologies. While this may be partially true there will almost certainly be a need to differentiate 5G in terms of social and economic value and this is probably only achieved by a step function increase in data rate and data reach based on large cell connectivity.

The radar community is adept at developing innovative waveforms and digital signal processing and techniques linked to front end transceiver technologies that can deliver significant broad band performance at any frequency from VHF to E band.

The automotive industry and automotive supply chain is adept at repurposing those technologies and techniques into robust low cost high value products. The collaborative opportunities are therefore obvious.

As Henry Ford said

'If everyone is moving forward together, then success takes care of itself'.

RTT 'Free to attend' 5G spectrum session at GSM World Congress Barcelona
Tuesday March 3 3.30 UK TI Stand Hall 7

'From C Band to E band and beyond'

Geoff Varrall CEO RTT Programmes
It is hard how 5G capacity and data rate, latency and energy efficiency expectations can be met without significant bandwidth allocation above 4 GHz. These are bands which support existing and new generation military high power radar and radio systems including telemetry and tele command, a combination of terrestrial and sub space wide area systems supported by LEO, MEO and GSO satellite networks. Parallel investment by the automotive industry is similarly enabling RF front end innovation, for example for 77 GHz automotive radar.

In this session we review the technical and commercial challenges (including coexistence challenges) for 5G radio technologies implemented into C band (4-8 GHz), X band (8-12 GHz), the K bands (12-40 GHz), V band and W band (40 to 110 GHz) and the particular opportunities of the E band sub bands at 71-76 GHz, 81-86 GHz and 92-95 GHz. We benchmark the progress being made with RF amplifiers and RF sub systems in defence and civilian radar and radio systems and the associated energy and cost impact on 5G wide area networks deployed into these bands.

Reserve a place by following this link
https://www.events.ukti.gov.uk/ukti-at-mobile-world-congress-7/registration/

Details on other free to attend sessions
https://www.events.ukti.gov.uk/ukti-at-mobile-world-congress-7/market-clinics/ukti-at-mobile-world-congress--3/

CW TEC Technology Conference in London March 24 2015

Spectral options for 5G and associated coexistence challenges and opportunities will be discussed in the CW Technology Conference in London this March with presentations from Avanti highlighting innovations in the satellite industry with parallel presentations from EE, Qualcomm, the BBC, BskyB, Radio Design, u-blox, CSR and Samsung on Wi FI, LTE, broadcasting and wearable technology.

Spaces on this event are limited so it's useful to book now rather than later

http://www.cambridgewireless.co.uk/cwtec/
http://www.cambridgewireless.co.uk/cwtec/programme/

You may also be interested in the presentations from events organised by the Cambridge Wireless Automotive and Transport Special Interest Group

http://www.cambridgewireless.co.uk/sigs/automotive/

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http://www.rttonline.com/tt/TT1998_008.pdf

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RTT, the **Jane Zweig Group** and **The Mobile World** are presently working on a number of research and forecasting projects in the mobile broadband, two way radio, satellite and broadcasting industry.

If you would like more information on this work then please contact **geoff@rttonline.com**

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