Health Issues relating to TETRA

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MTHR Programme

& Home Office TETRA Study
Management Committee

TETRA
(Terrestrial Trunked Radio)

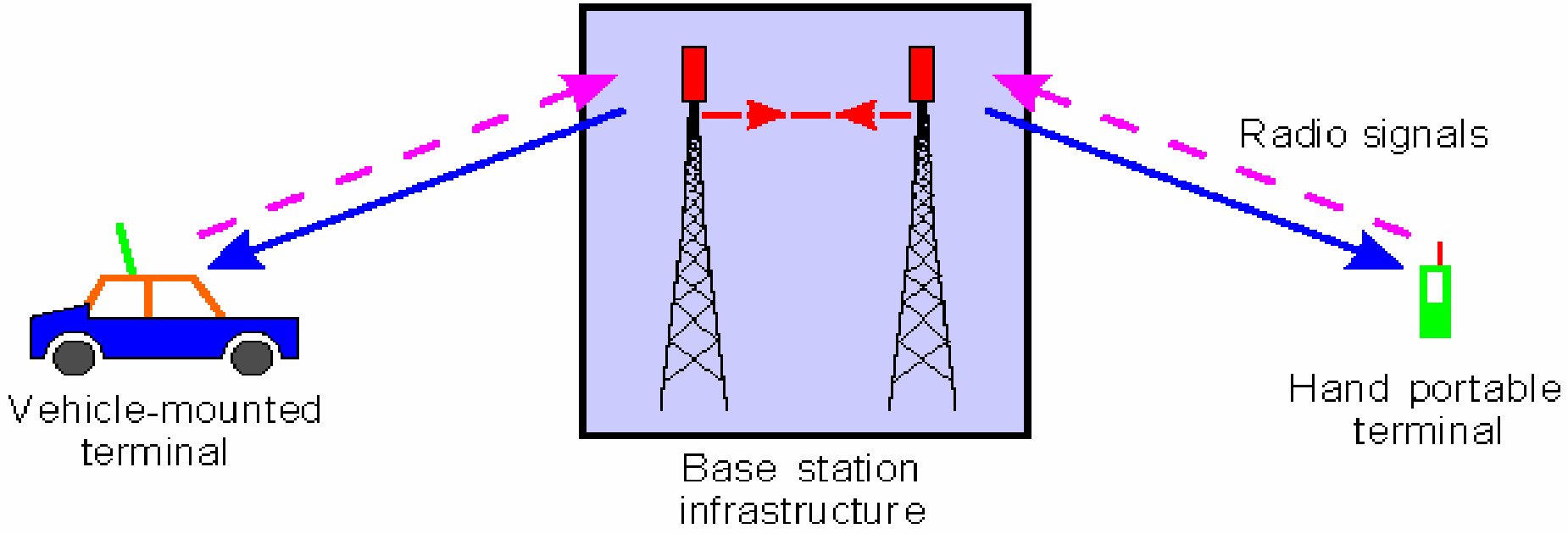
- Digital radio system.
- Contracts in 88 countries
- Emergency services (Ambulance, Fire and Rescue, Police)
- Commercial organisations.

Technology

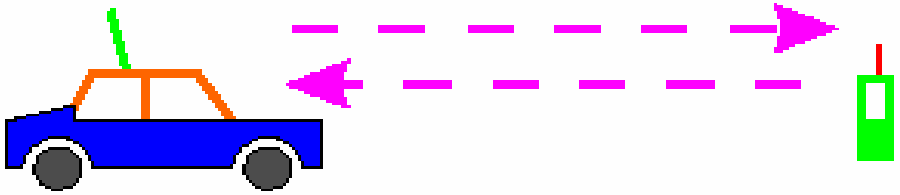
- Network system similar to that of mobile phones.
- Digital not analogue.
- Frequency of handsets is around 400 MHz
- Frequency similar to that of analogue radios previously used by emergency services.
- GSM mobile phones operate at 900 or 1800 MHz, UMTS around 2000 MHz .

Technology

- TETRA 400 MHz signal from handsets is pulsed at 17.6 Hz.
- TETRA signals from base stations (masts) is not pulsed.
- Analogue radio signals were not pulsed.
- GSM phones are pulsed mainly at 217 Hz.



(a) Trunked Mode Operation (TMO)



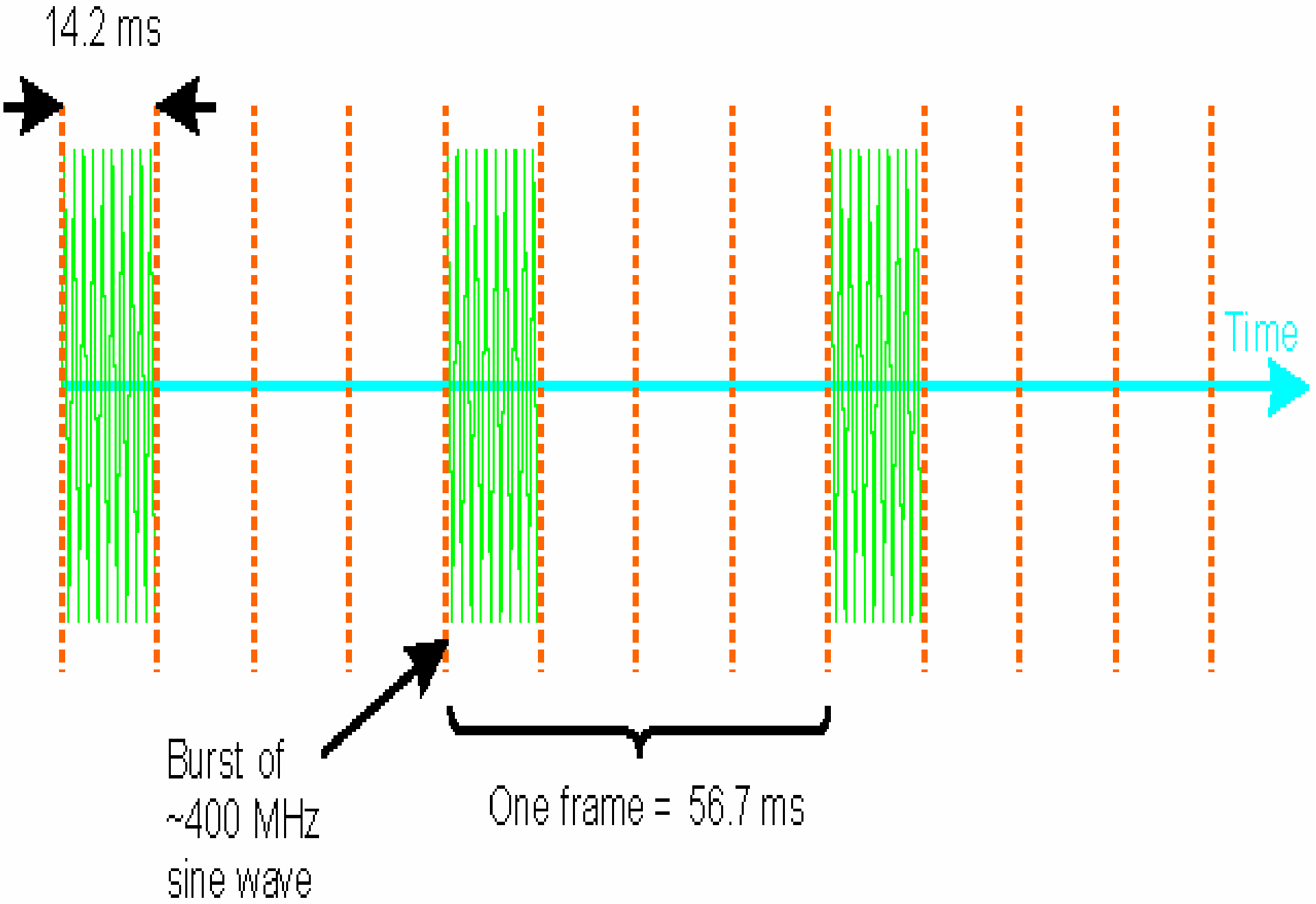
Continuous signal (not pulsed)

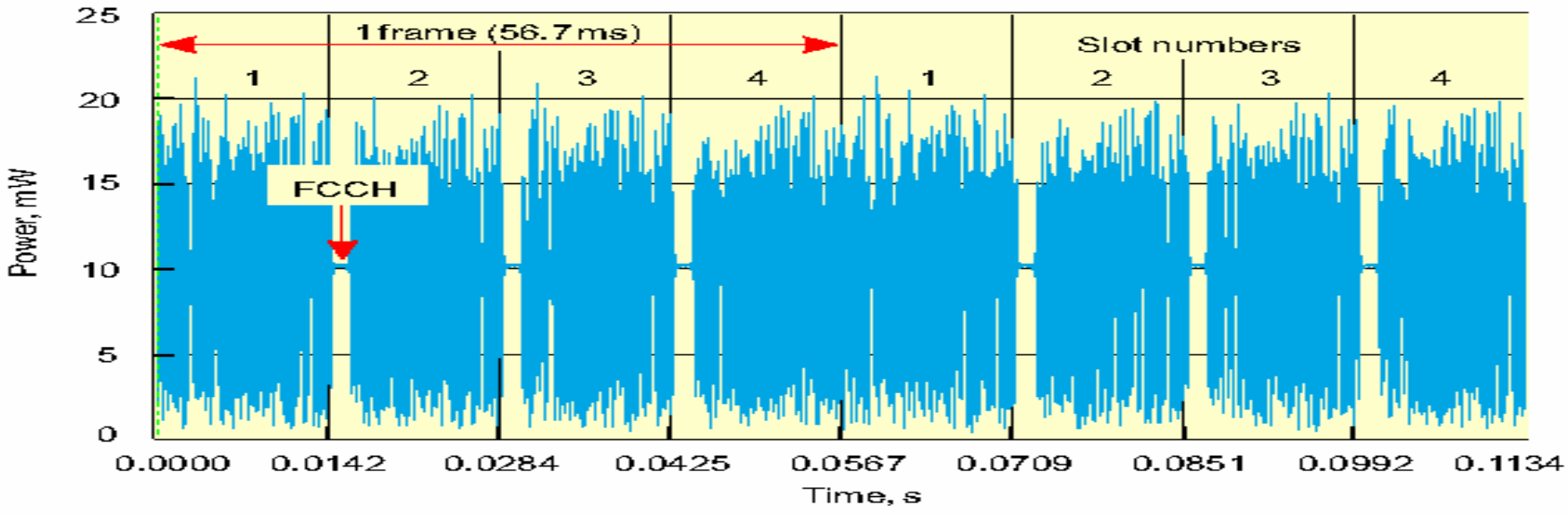
Pulse-modulated signal

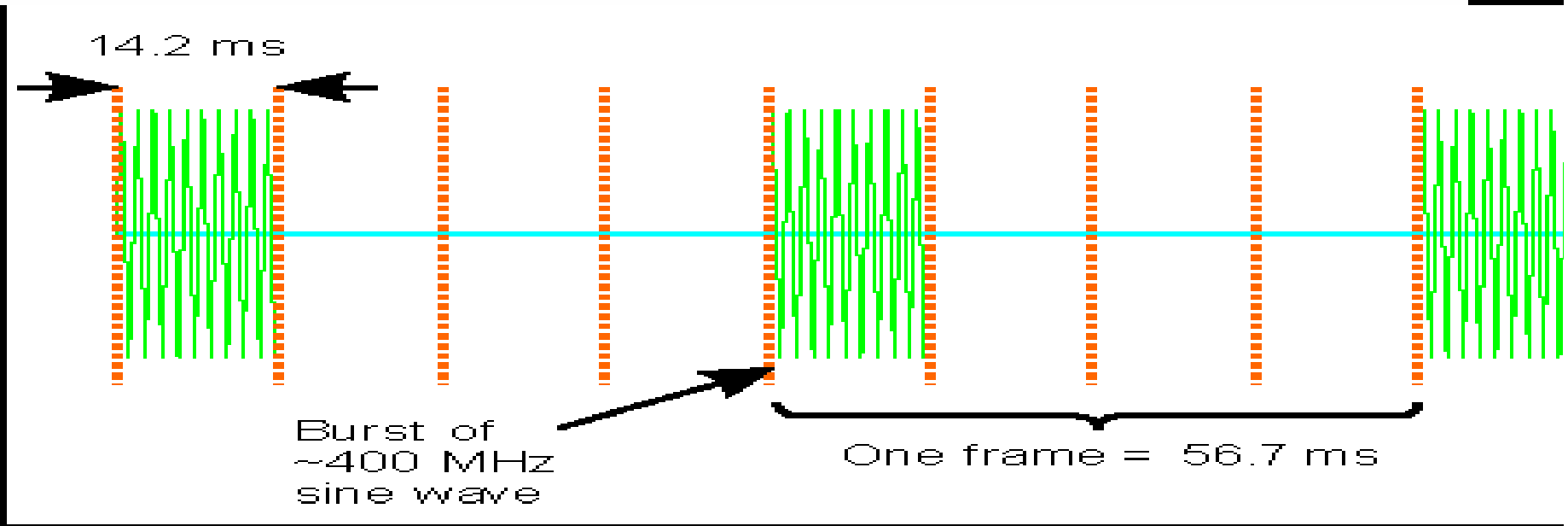
(b) Direct Mode Operation (DMO)

Why pulsed? Time sharing

- Typical base station emits 4 different carrier frequencies (each close to 400 MHz).
- With no time sharing, each frequency could only communicate with one handset.
- By time sharing, each frequency can communicate with 4 handset so base station can communicate with 16 rather than 4 mobiles.


14.2 ms
Time
Burst of
~400 MHz
sine wave
One frame = 56.7 ms


1 frame (56.7 ms)
Slot numbers
1
2
3
4
1
2
3
4
FCCH
Power, mW
25
20
15
10
5
0
0.0000
0.0142
0.0284
0.0425
0.0567
0.0709
0.0851
0.0992
0.1134
Time, s


14.2 ms
Burst of
~400 MHz
sine wave
One frame = 56.7 ms

Maximum Power emitted from TETRA mobile terminals

- Handsets: 1W (3W)
- Vehicle mounted: 3W (10 W)
- Airwave is designed for the lower values in each case. But terminals with the higher powers are available.

Adaptive Power Control

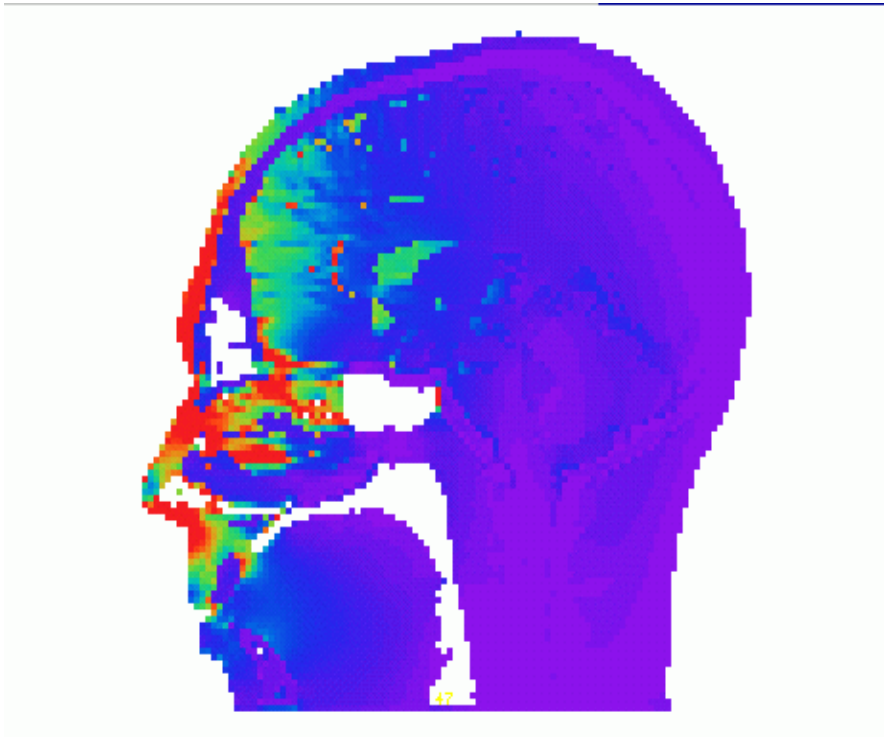
- Base station controls the maximum power emitted from a handset to the smallest value needed for good communication.
- If the handset is outside and near a base station it emits a maximum of 30 mW rather than 1W.
- As it moves away (or is in a building etc etc) the power steadily increase towards the maximum of 1 W.

Power from TETRA etc.

Phone	Peak	Average	Adaptive Power Control
Analogue radios	1.5	1.5	No
TETRA (1W)	1	0.25	Yes (not DMO)
GSM 900 (“mobile phone”)	2	0.25	Yes
GSM 1800	1	0.125	Yes

Absorption of Radio Waves in head

- Handset held in front of the face
- Radio waves penetrate the head for a few cm
- Some of the radio energy is absorbed
- SAR describes local energy absorption



Exposure Level (SAR)

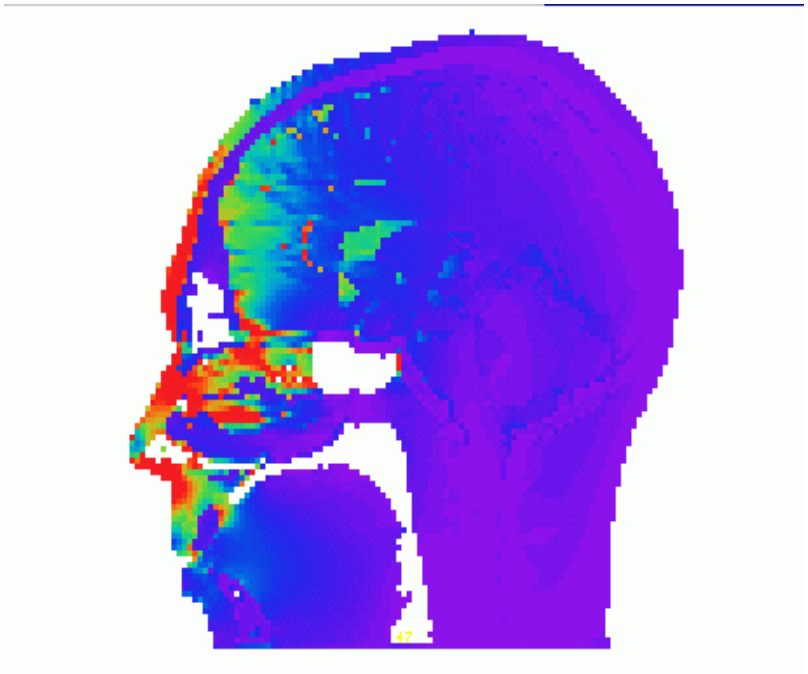
- How does one measure exposure?
- Specific Absorption Rate (SAR).
- SAR = rate at which energy is absorbed in a particular part of the body. W/kg.
- Averaged over 10 g of tissue (very roughly a 1 cm cube) and over 6 minutes.

How do you obtain SAR values in the head?

- **Either**: use a hollow model of a head (a phantom head) containing a fluid with similar electrical properties to the head. Move a probe around which measures the electric field and hence the SAR.
- **Or**: calculate the SAR by numerical modelling.

Computed SAR values

- Numbers are computed SAR values.
- Usually quote the largest value for a particular phone in a particular position



TETRA Exposure Levels

- Measured SARs of earlier TETRA handsets held next to the head are comparable to those of mobile phones as expected since the power outputs are similar.

- Have not seen SAR values of recent handsets but would expect them to be similar since the powers are the same.

Base Stations

- Exposure to the public from base stations is at least a thousand or so times weaker than that from phones or handsets
- Signals from TETRA base stations are not pulsed.

COULD EXPOSURE TO TETRA SIGNALS LEAD TO HEALTH EFFECTS?

Heating effects from TETRA handsets.

- Would raise temperature of a **small part of the head** by, at most, about 0.05^0C (if speaking for 6 mins and if a long way from mast or inside building etc)
- The natural daily variation of **the whole body** is about 1.0^0C.
- So very unlikely that heating from TETRA signals could lead to health effects

Non-Thermal Mechanisms?

- Guidelines based on the only known health effect-heating. Could there be any non-thermal mechanisms that cause health effects at lower exposures?
- Nearly all likely mechanisms produce effects on cells etc which are small compared to these already there because our cells etc are in constant motion – ”thermal noise”.
- 2 mechanisms might just be comparable and so might just give rise to small but detectable biological effects??
- Unlikely mechanisms?? Mechanisms no one has yet thought of ??

Biological and Health effects

UK SCIENTIFIC REVIEWS:

- Stewart Report, May 2000
  - –Independent group of scientists. Set up by UK Government to look mainly at public mobile phones and base stations.
- AGNIR Report, Jan 2004
  - –AGNIR (Advisory Group on Non-Ionising Radiation- Independent group of scientists who advise the Health Protection Agency)

MAIN CONCLUSIONS

The balance of evidence to date suggests that exposures to RF radiation below guideline levels do not cause adverse health effects to the general population.

However:

- Published research has its limitations
- Mobile phones have only been in widespread use for a relatively short time
- Continued research is needed.

Health Issues specific to TETRA?

Pulsing at 17.6 Hz

- Stewart Report: “pulsing near 16Hz should be avoided”.
- Recommendation was based on work mostly in 70s and 80s indicating that “calcium efflux” effects were produced by RF pulsed at 16 Hz.

Calcium Efflux

Brawin et al UCLA(1975):

- Pieces of newly killed chicken brains immersed in solution of radioactive calcium. Transferred to salt solution.

- Calcium efflux – movement of Ca ions from cells – apparently speeded up by pulsed 147 MHz radiation. Greatest effect for pulse rate around 16 Hz.

Calcium Efflux

- Initially replicated by other experiments.
- However 3 more recent experiments have not seen any effects.
- International report in 1993: the effect does not exist. Earlier results must be the result of some sort of fault in the experiments?

AGNIR report on TETRA, Nov 2001

"Areas of uncertainty remain about the biological effects of low level RF radiation particularly about modulated signals.

However current evidence suggests it is unlikely that the special features of TETRA pose a hazard to health".

Research recommended in several areas

13 Research Projects on TETRA funded by MTHR and Home Office

- MTHR (Mobile Telecommunications and Health Research Programme) set up in 2000 following Stewart Report.
- Funded by government and industry. Final budget £8.8M. 28 projects funded, 5 dealing specifically with TETRA.
- Home Office funded directly 6 more TETRA projects.
- 2 new MTHR TETRA projects as result of additional funding.

TETRA Research Projects

- 2 on calcium efflux
- 6 volunteer studies (5 handsets, 1 base station) 2 of these 6 are new projects)
- 1 on demodulation
- 1 health monitoring study
- 3 on dosimetry

Calcium Efflux

- DSTL –John Tattersall to report
- Cambridge

Volunteer studies of TETRA

Handsets

- Cognitive studies (DSTL Sarah Smith to report)
- Cognitive studies (Imperial College)
- Blood pressure (Sheffield)
- Electrical activity of the brain (Bristol)
- "Unpleasant symptoms", headaches, nausea etc – (King's College, London)

•Base stations

- Cognitive studies: volunteers include people reporting hypersensitivity (Essex)

Health Monitoring, Demodulation and Dosimetry

Health Monitoring Study

- Imperial College

Demodulation

- Bradford/HPA/Maryland

Dosimetry

- SARs from TETRA handsets –HPA
- Exposure from handsfree kits – MCL
- Exposure in vehicles – MCL - Phil Chadwick to report

Epidemiology : GSM Phones

- Epidemiological studies of brain tumours
  - No association of increased risk for exposures < 10 years
  - Some evidence of increased risk for exposures > 10 years

- Real effect or bias? (why is bias only significant after >10 years?)

Latency of cancers and other diseases

- For most cancers etc, detectable symptoms only appear 10-15 years or more after the event that caused them.
- Since rather few people have used mobile phones for more than 10-15 years, it is not possible at present to say whether RF exposure, including TETRA, increases the risk of getting cancer or other diseases.
- Need to continue research

MTHR2

- Extension proposed to the MTHR programme –MTHR2
- Major components:
  - –an epidemiological cohort study
  - –studies of children who may be more at risk than adults
  - –2 TETRA volunteer studies (1 handset, 1 base station).

Summary

Exposure from TETRA handsets

- Similar to mobile phones
- 1/20 of guideline levels (normally less because not speaking for 6 mins and because handset output is less than the maximum- APC etc).

Pulsing

- No evidence for any biological or health effects- early experiments suggesting calcium efflux have not been replicated by more recent experiments using more sensitive methods.

Summary.

- Because of long latency, cannot rule out at this stage the possibility that RF exposure, including exposure from TETRA handsets, could increase the risk of cancer and other diseases. More research is needed.
- Since the exposure from base stations, including TETRA base stations, is very much less than that from handsets, any increased risk of disease from these seems likely to be much less than that from handsets.