

# 5G MILLIMETER-WAVES HEALTH & ENVIRONMENT

*we assume safety but...  
we have no idea what will happen*

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There are things **we know that we know**.

There are **known unknowns**. That is to say there are things that we now know **we don't know**.

But there are also **unknown unknowns**. There are things **we don't know we don't know**.

**Donald Rumsfeld**, US Secretary of Defense, NATO Briefing, June 6, 2002  
[<http://www.nato.int/docu/speech/2002/s020606g.htm>]

Policies concerning human health and EMF are based solely on “*what we know that we know*”.

“*What we know that we do not know*” is dismissed as irrelevant.

Anything that could lead to the implementation of precautionary measures is considered as “*scaremongering*”.

# The Problem

- ▶ Rapidly developing wireless technology
- ▶ Human health hazard research lagging behind
- ▶ Impact on living environment of humans lags behind
  
- ▶ Deployment of technology based on **assumed lack of health hazard**
- ▶ **The assumed lack of health hazard might be false;** in past it happened...
- ▶ Very limited biomedical research shows potentially hazardous outcomes on humans and environment
  
- ▶ The same scenario repeats = not learning from the past experiences

# World Health Organization: Definition of Health

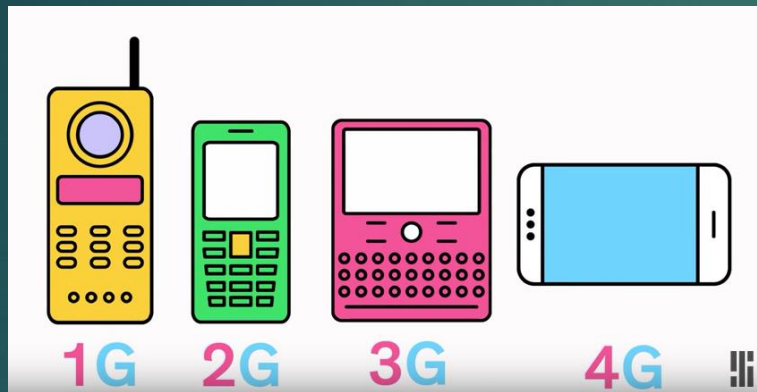
*“Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”*

- ▶ According to the WHO, it is a health effect when people are stressed by the worry of radiation exposure
- ▶ This applies to EMF and wireless communication technologies
- ▶ The larger the “worried” population is, the larger the health problem is

# Cell Phones: The *assumed* lack of health hazard appears to be false

- ▶ In early 1980s communications technology developed for US Department of Defense was put into commerce
- ▶ Food and Drug Administration (FDA) allowed cell phones to be sold without pre-market testing for human health hazard
- ▶ FDA rationale - the “*low power exclusion*”
  
- ▶ In 2011, based on the post-deployment research, International Agency for Research on Cancer (IARC) classified cell phone radiation as a *possible* human carcinogen

# 5G Technology



Source: IEEE Spectrum

<http://spectrum.ieee.org/video/telecom/wireless/everything-you-need-to-know-about-5g>

# Serious limitations of biomedical research on millimeter-waves

- ▶ Very limited number of studies
  - ▶ EMF Portal ([www.emf-portal.org](http://www.emf-portal.org)) lists <200 studies
  - ▶ Few more studies possible to find in PubMed database
- ▶ Lack of studies examining responses of human physiology to exposure (human volunteer studies)
- ▶ Lack of studies on chronic exposures
- ▶ Studies from a very limited number of research groups
- ▶ Lack of replication studies confirming correctness of observations



# Environment of human skin

[examples, not a comprehensive overview]

- ▶ False assumption that because radiation will be absorbed by skin only there will be no major health problem
- ▶ Functions of the skin microbiota in health and disease by James A. Sanford and Richard L. Gallo; *Semin Immunol.* 2013 Nov 30; 25(5): 370–377.
  - ▶ “...The skin, the human body’s largest organ, is home to a diverse and complex variety of innate and adaptive immune functions...”
  - ▶ “...the skin immune system should be considered a collective mixture of elements from the host and microbes acting in a mutualistic relationship...”

# Human volunteer studies on millimeter-waves

*[examples, not a comprehensive overview]*

- ▶ Just a *handful* of studies with a *trickle* of information
  - ▶ Local skin heating
  - ▶ Effect on pain sensation
  - ▶ Effect on acupuncture sites
  - ▶ Effects on blood flow

# In vitro effects on human cells

*[examples, not a comprehensive overview]*

- ▶ Just a couple of hundreds of studies, with effects and without effects
  - ▶ Promotion of synthesis of extracellular matrix
  - ▶ Induction of apoptosis
  - ▶ Promotion of proliferation and G1 to S phase transition
  - ▶ Inhibition of NO-dependent apoptosis via p38MAPK pathway
  - ▶ Changes in protein expression
  - ▶ Effects on NF-KB pathway via TNF-alpha and cyclophosphamide
  - ▶ Effects on c-fos expression
  - ▶ Lack of effects on Hsp27 and Hsp70 (no thermal effect?)
  - ▶ Number of studies shows the opposite, no effects...

# Individual sensitivity

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*[examples, not a comprehensive overview]*

- ▶ At 42 GHz effect on human blood cells depended on the dose radiation and on the “individual peculiarities of donors of the blood cells” (study from 1998)
- ▶ Skin of different people reacts differently to stimuli – will it happen with millimeter-waves... we have no idea because we did not examine it at all
- ▶ Research on physiological effects of millimeter-waves on skin, and its impact on the whole body, is urgently needed

# Specific “electromagnetic effect”

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[examples, not a comprehensive overview]

- ▶ Transcriptome analysis reveals the contribution of thermal and the specific effects in cellular response to millimeter wave exposure. Habauzit et al. *PLoS One*, 2014, 9:e109435-1-e109435-10
  - ▶ Exposure affected gene expression
  - ▶ Seven genes affected and confirmed
  - ▶ Effect observed when temperature of cells increased
  - ▶ When temperature was controlled effect disappeared but...
  - ▶ ...just by increasing temperature it was not possible to mimic the thermal-exposure effect on genes
  - ▶ Hence, proposed possibility of an “*electromagnetic*” component of the exposure effect

# Effects on microbiota & microbiome

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*[examples, not a comprehensive overview]*

- ▶ A microbiota is an "ecological community of commensal, symbiotic and pathogenic microorganisms" found in and on all multicellular organisms studied to date from plants to animals. A microbiota includes bacteria, archaea, protists, fungi and viruses
- ▶ The microbiome comprises all of the genetic material within a microbiota (the entire collection of microorganisms in a specific niche, such as the human skin). This can also be referred to as the metagenome of the microbiota.
- ▶ EMF effects on microbiota and microbiome apply to the whole EMF spectrum used in wireless communications

# Effects on microbiota & microbiome

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*[examples, not a comprehensive overview]*

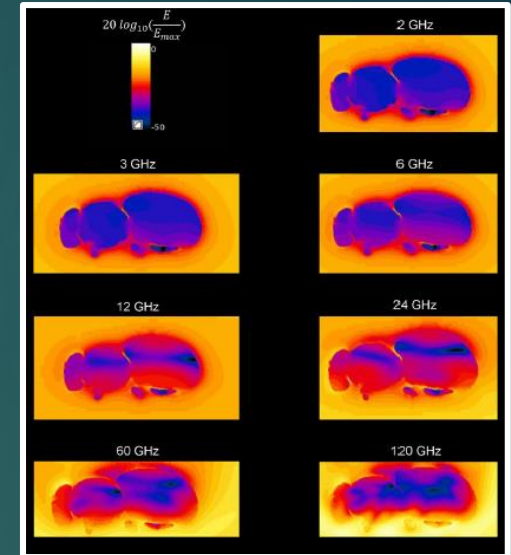
- ▶ Just a handful of studies (<20?)
  - ▶ Inhibition of bacterial growth (53 GHz)
  - ▶ Enhancement of bacterial sensitivity to antibiotics (53 GHz)
  - ▶ Inhibition of growth and viability of bacteria (70 GHz)
  - ▶ Effects on metabolic pathways in bacteria (53 GHz)
  - ▶ Co-effects of mm-Waves and UVC (enhanced survival)
  - ▶ Co effects with X-rays (repair of the damage)
  - ▶ Effects on structure of bacterial genome

# Sensitivity of insects (e.g. bees)

[examples, not a comprehensive overview]

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- ▶ Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz. Thielens et al. (team included Luc Martens and Wout Joseph); *Scientific Reports* 2018, 8:3924
- ▶ “...Our simulations showed that a shift of 10% of the incident power density to frequencies above 6 GHz would lead to an increase in absorbed power between 3–370%...”
- ▶ “...This could lead to changes in insect behaviour, physiology, and morphology over time due to an increase in body temperatures, from dielectric heating...”





# Industry funded review study: An unfounded claims of safety for 5G

- ▶ Safe for Generations to Come. Wu et al. *IEEE Microw Mag.* 2015; 16: 65–84
- ▶ In April 2014, the Brooklyn 5G Summit, sponsored by NOKIA and the New York University (NYU) WIRELESS Research Center
- ▶ **Assumption:** low-power = not causing health effects because it is non-thermal
- ▶ “...Compared with lower frequency bands, **relatively little careful research** has been conducted evaluating the potential of **more subtle long-term effects** than tissue damage due directly to heating at mmWave frequencies...”

# Déjà vu?

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- ▶ Cell phones 1G – 4G
  - ▶ 1G technology emitting low power - no health hazard envisioned in 1980's
  - ▶ Today – 3G & 4G – technology emitting low power – classified by WHO/IARC as a possible human carcinogen
- ▶ Future 5G and Internet of Things (IoT)
  - ▶ Technology emitting low power – no health hazard (?)
  - ▶ No research showing hazard because no research done (!)
  - ▶ The future research outcome (?)

# Conclusions 1/2

- ▶ Very limited number of studies by very limited number of research groups
- ▶ Effects observed at low-level exposures
- ▶ Lack of attempts of replication is additional cause of concern
- ▶ Potentially, the observed effects may impact human health and human environment
- ▶ The observed effects justify further research
- ▶ The need of research is very urgent because of the rapidly ongoing deployment of 5G technology

# Conclusions 2/2

- ▶ We do not know how humans and animals will be affected by the 5G-emitted radiation
- ▶ **Research has not been done**
- ▶ Currently, it is simplistically assumed that low power of radiation will not cause effects
- ▶ The history of cell phones teaches that the simplistic “*low-power = safety*”-assumptions might be incorrect