

# IoT in eHealth – diagnosis, therapy, recovery, wellness

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# The importance of health

- Health, good health, is vital, and all forms have interplay
  - Societal
  - Economic
  - Mental
  - Physical
  - ... an infinite number of others?
- Understanding and enforcing good health needs measurement
  - IoT offers opportunities for ICT involvement in eHealth in the form of sensors, actuators and **data**

# Some statistics for thought

(from worldometer.com on 4<sup>th</sup> October)

## HEALTH

9,827,652	Communicable disease deaths <a href="#">this year</a>
377,958	Seasonal flu deaths <a href="#">this year</a>
5,754,286	Deaths of children under 5 <a href="#">this year</a>
32,370,096	Abortions <a href="#">this year</a>
233,992	Deaths of mothers during birth <a href="#">this year</a>
43,990,146	HIV/AIDS infected people
1,272,628	Deaths caused by HIV/AIDS <a href="#">this year</a>
6,217,494	Deaths caused by cancer <a href="#">this year</a>
298,530	Deaths caused by malaria <a href="#">this year</a>
5,950,720,732	Cigarettes smoked <a href="#">today</a>
3,784,458	Deaths caused by smoking <a href="#">this year</a>
1,893,423	Deaths caused by alcohol <a href="#">this year</a>
811,808	Suicides <a href="#">this year</a>
\$ 302,852,120,335	Money spent on illegal drugs <a href="#">this year</a>
1,021,923	Road traffic accident fatalities <a href="#">this year</a>

## Coronavirus Cases:

627,104,817

[view by country](#)

## Deaths:

6,562,340

## Recovered:

606,882,398

## WATER

3,423,561,463	Water used <a href="#">this year</a> (million L)
637,509	Deaths caused by water related diseases <a href="#">this year</a>
778,656,870	People with no access to a safe drinking water source

## GOVERNMENT & ECONOMICS

\$ 6,376,291,797	Public Healthcare expenditure <a href="#">today</a>
\$ 4,289,032,350	Public Education expenditure <a href="#">today</a>
\$ 1,861,855,598	Public Military expenditure <a href="#">today</a>
63,247,504	Cars produced <a href="#">this year</a>
117,295,851	Bicycles produced <a href="#">this year</a>
181,284,487	Computers produced <a href="#">this year</a>

## FOOD

864,180,940	Undernourished people in the world
1,733,810,120	Overweight people in the world
819,161,295	Obese people in the world
12,039	People who died of hunger <a href="#">today</a>
\$ 247,539,730	Money spent for obesity related diseases in the USA <a href="#">today</a>
\$ 74,418,573	Money spent on weight loss programs in the USA <a href="#">today</a>

# Where is the IoT opportunity?

In ETSI's [White Paper 33](#) we stated:

- ... whilst very little of ICT is eHealth specific, all of eHealth depends on ICT. If a network cannot meet the requirements of an eHealth request for security, latency, delay, reliability and throughput it will not be allowed to transport the eHealth information. If eHealth is to be ubiquitous then all technical specifications for the communications infrastructure have to be eHealth ready and designed with the eHealth domain in mind. In short ICT standards should be designed with the assumption that they will be applied in a health environment and as part of a global ICT solution to evolving health issues

It's not enough for ICT standards to be designed with a view to be eHealth ready, we (people, organisations, governments) need to be eHealth ready

About 9% of world GDP goes to healthcare (so about \$8trillion/year), IoT has an opportunity to access a large part of this and grow the figure too



# What is the boundary of the health environment?

Again from [White Paper 33](#) where we stated:

- ... ICT standards should be designed with the assumption that they will be applied in a health environment and as part of a global ICT solution to evolving health issues

This statement appears to imply we can define a boundary of the health environment

- In societal and human terms we shouldn't constrict it though → it tends to become boundary-less
- Closing the border before we know what impacts health is unsafe: Causal, circumstantial, genetic, environmental factors in health make the boundary uncertain

Healthcare choices are ethically difficult (e.g. triage at accident scenes, choosing who receives donor organs)

# Control and measurement

As engineers we need to measure in order to understand, react and control

- Measurements for health are contextual → knowing somebody's heart rate is of little value without knowing their activity during the reading
- Health problems are rarely single factor problems
  - Economic problems may lead to mental health problem that may in turn lead to physical health problems
  - Addiction problems that cause health problems don't get fixed at the health problem but need to address the addiction itself
- To quote "House" everyone lies – IoT and the ICT domain, with proofs of provenance and integrity, may allow greater objectivity in data for eHealth

# eHealth promotes ill-health?

More measurement will uncover more problems

- What measurements should be made and how often?

Measurement has to be assured, reliable, repeatable

- The metrics have to be open, standardized and explicable

Understanding what measurements mean

- Bulk trends, versus individual data (BMI as a snapshot of a population may be meaningful but meaningless for an individual)

Coercion through technology

- IoT devices are not benign and are often a root cause of ill health

Technology over-riding common sense

- The over-training dilemma (no gain without pain?)



# Health, wellness, fitness? How will IoT fit?



There are wellness devices not “certified” for use in health but give the user health advice

- Smartwatches track RHR, HRV, sleep patterns, active versus resting time, all of which can give early indication of future health risk
- Introduces the idea of 24/7 health/wellness monitoring

Not all of the population appears to be interested in health

- Example: The dangers of smoking have been known for decades but people still start – do they care? Do they understand the risk? Is it because the risk is not 100% causal?

The challenge to overcome is to achieve acceptance of new data sources (IoT devices) as contributors to health awareness

- More willingness to seek medical IoT device certification at lower cost to developers
- Adoption of a few security principles:
  - Secure by default
  - Private by design
  - Verify before connect and integrate (Zero Trust model)



# A stitch in time saves nine

## Early intervention is essential

- Fix when an illness is minor

## Cry-wolf syndrome?

- Always intervene even if the last  $n$  interventions found no problem – machines may be better at this
- Correlate and verify to minimize unnecessary intervention but don't ignore the cry for help

## Forward planning

- Weather events cause health issues with specific treatments – so knowing when they'll happen is essential. Weather data is eHealth data
- Traveler movements also move illnesses. Travel data is eHealth data. Knowing who goes where in advance may allow healthcare preparedness

# ICT and data allows dogma to be challenged

Peptic ulcers were assumed to be related to acid:

- The dictum of Karl Schwarz: “No acid – no ulcer” provided the framework for ulcer research
- Conventional treatment often used anti-acids

Data and simulation (and a bit of unethical behaviour) allowed dogma to be challenged

- Identification of a gut resident pathogen as root cause
- Nobel prize was awarded to Robin Warren and Barry Marshall for their discovery of *Helicobacter pylori* as pathogen in the gastrointestinal tract
- Correlation (existence of pathogen in all cases) later developed by data and experiment into identification of the pathogen as causation

# ICT and data – do we need AI?

eHEALTH is a massive consumer of data

- Data mining will help find correlation
- Machine learning will learn to find correlations
- AI added to ML, with oversight from medical and science professionals, will help identify causation from the data

The role of digital twins is going to be critical to help tread the ethical tightrope

- Research on active models
- Major human systems (cardio-vascular, respiratory, digestive, endocrine, lymphatic, sensory, ...) can all be modelled and used as real time monitors of real people

# AI in eHealth?

Given enough data, and enough understanding of data relationships, and of system dependencies (strong and weak), AI can have a positive role

- Diagnosis – helping to identify what is actually wrong with a patient
- Treatment – helping to determine effectiveness of treatments and therapies
- Prevention – early identification of “misbehaving systems”

The challenge is to ensure that the AI is properly supervised, transparent and explicable

- The activity in ETSI ISG SAI and in ISO JTC42 will help here



# IoT and eHealth security

Default has to be to trust nothing, then to establish and maintain strong security/trust relationships

Adopt a Zero Trust Architecture in IoT and eHealth to establish the system trust value – the trust in the system is built up from the set of individual trust associations in the entire system.

This impacts everything in the eco-system. Hardware, software, communications flows, data sources, data sinks, data processors. The trust chain is a set of AND relationships (trust A AND B AND C AND D AND E AND F AND ... AND X). Every node, every junction, every element.

●  $SystemTV = \sum TrustValue.TA$

# eHealth challenges

## Health care is a political issue

- Interventionist healthcare is expensive – can be managed by the state
- Preventative healthcare requires societal management – has to be managed by the state

## Health data is very personal and very public simultaneously

- My health status if made public may be used to discriminate against me
- Societal reaction can only occur if knowledge of the incidence metrics are public

## The lifetime of health data is largely indeterminate

- Lifetime++ as it needs to be linked to maternal and genetic health for forebears and offspring
- Data protected has to be also protected in 10, 100, 200 years from now

## In summary

- IoT, as ICT, has many opportunities to change the health, wellness, happiness, indices
- Those opportunities require change in attitudes towards devices and data
- Ethical use of acquired knowledge is a significant challenge
- Security models to allow secure, trusted eHealth systems to work across the entire health system exist today and will be embellished to ensure and assure that users, at the heart of eHealth, are secure and safe



**Thank you for your attention**



# Any (further) questions?

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