

# Information and Communication Sciences: Where to Go from Here?

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# Outline

## 1. History

- **The story of MICS**
- **Slides from the bubble years**

## 2. Twelve years later

- **What have we really achieved**
- **Anything we could have done better?**

## 3. Lessons learned

- **What does it mean for academia**
- **What does it means for SNSF**

## 4. A few thoughts for the road

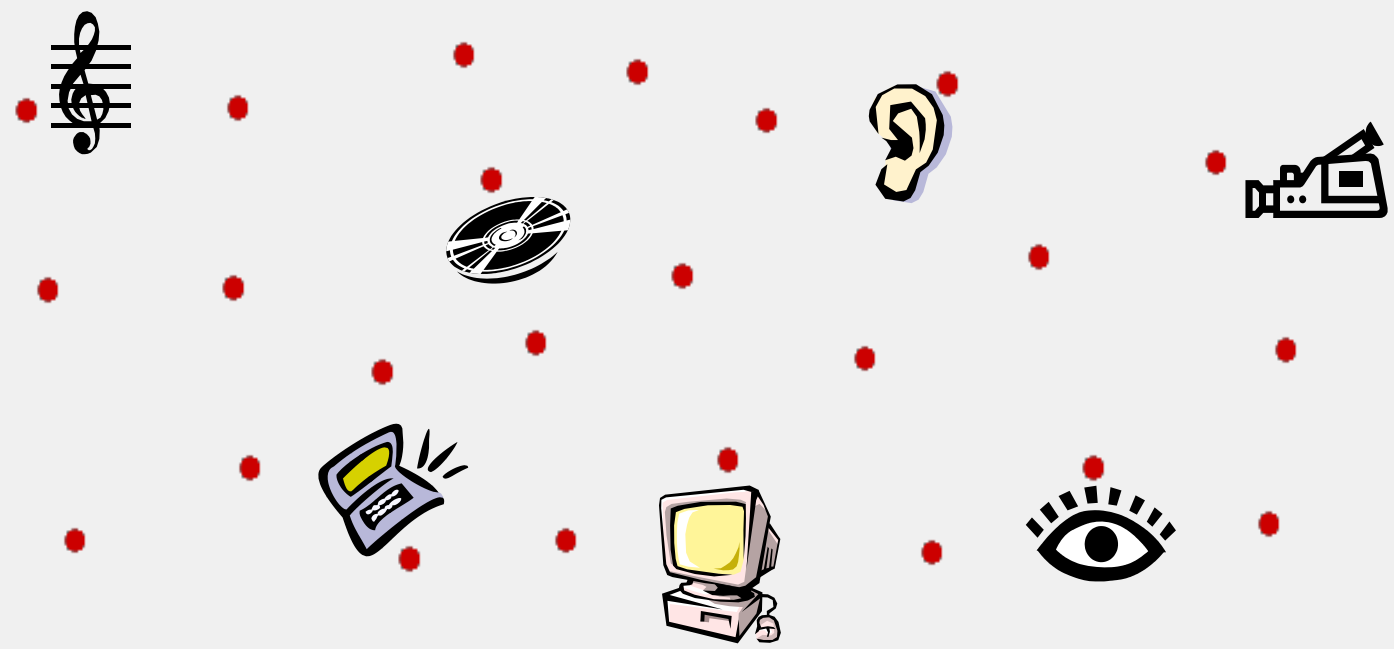
- **What might matter for the next twelve years...**

## 5. Conclusion

# A new paradigm (1)

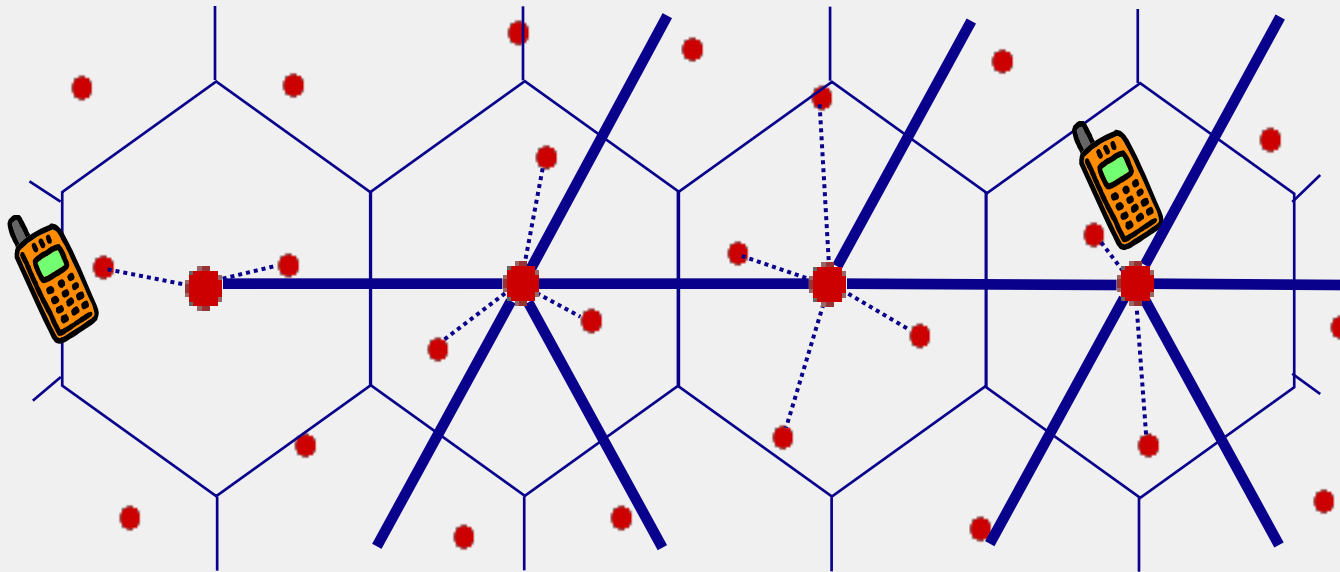
## The problem

Arbitrary communication and information exchange...  
under constraints



## A new paradigm (2)

### The "classic" solution: wireline + wireless

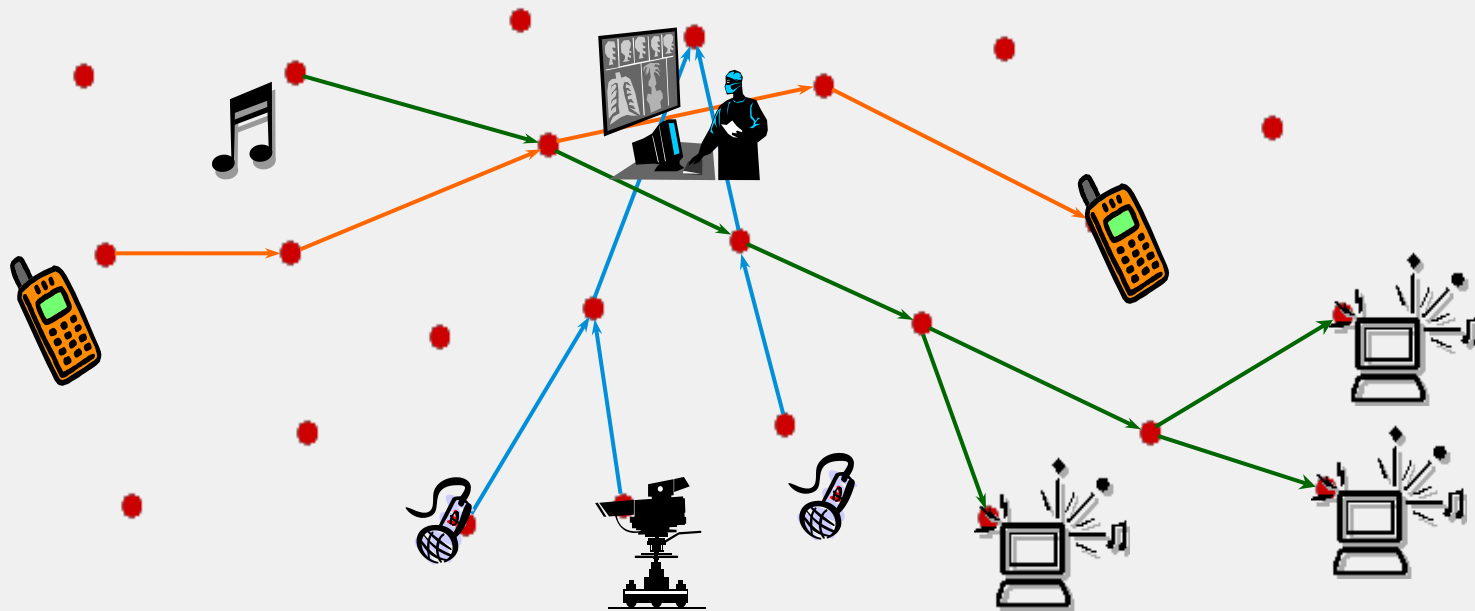


- Characterized by **heavy fixed infrastructures**
- Still under full study and development !
- Evolution of wireless communication equipment:  
computational power ↗, size ↘, price ↘, ~ transmit power



# A new paradigm (3)

**What if... decentralized, self-organized systems:**  
Terminals + nodes = terminodes

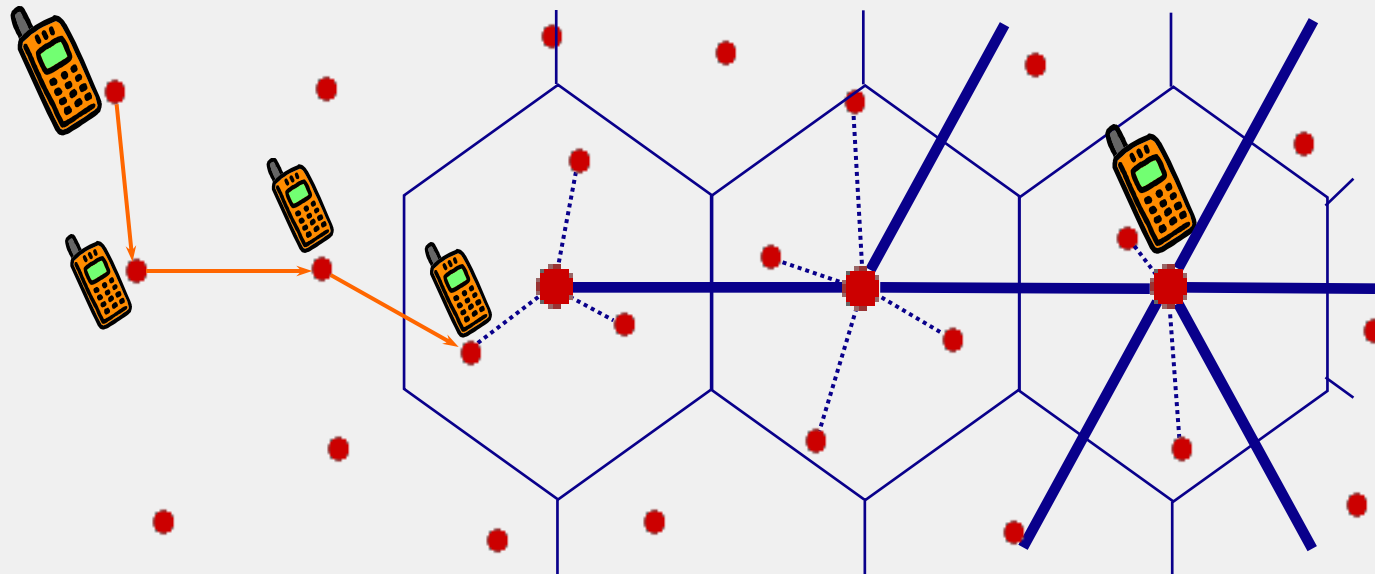


Questions: - can one do it ?  
- upsides and downsides ?  
- how to actually do it ?



# A new paradigm (4)

## Self-organized systems may complement existing networks



Examples:  
multihop access networks, hybrid networks, sensor networks



# A new paradigm (5)

## The key questions

- What are the achievable capacity and the limits of performance?
- Can such a system scale ( $10^3$ ...  $10^6$ ...)?
- What are the mechanisms to make it work (e. g. routing)?
- Is it secure (distributed trust)?
- How to ensure a certain quality of service?
- What kind of software architectures are suitable?
- Can it lead to new business models?



- Distributed, self-organized systems is the **next big challenge** in information and communication systems !
- Raises **fundamental questions**, eg
  - on the mathematics of self-organized systems
  - on multi-user information theory
  - on distributed information systems
  - on self-configurable software systems
- Many of these questions are **very hard**, and it would be a miracle if we (or others) solved all of them !





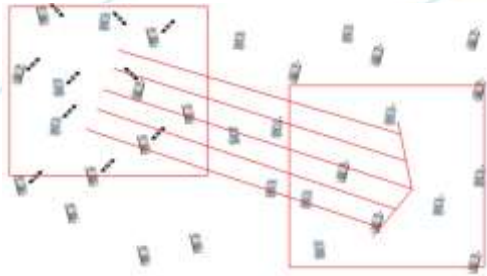
- Raises **challenging technology issues**, eg on
  - bootstrapping and self-organized Medium Access Control
  - protocols and network functions
  - highly scalable and robust multimedia services
  - network- and environment-aware applications
  - robust distributed information systems
- Such questions are at the **forefront of R&D** in Information and Communication Technology
- These topics will be **as relevant as now** (if not more) in 10 years



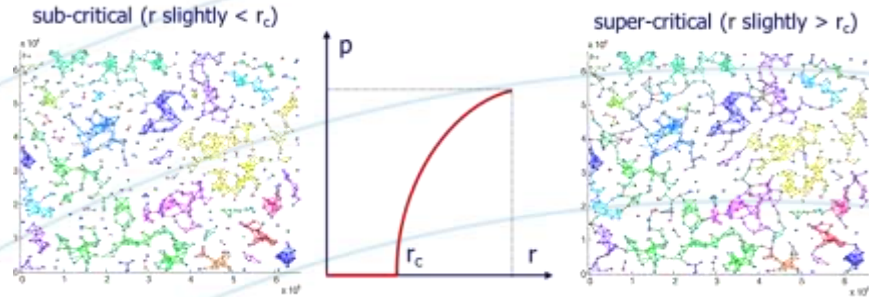
# What was really achieved (1)?

Sep 2012

- A few examples among many
  - Theory: capacity of ad-hoc networks

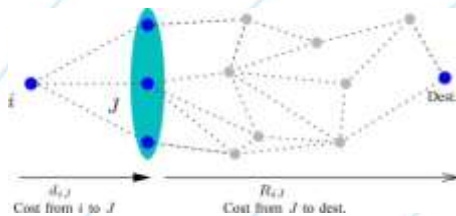


Hierarchical cooperation (Ozgun et al.)



Percolation theory (Dousse et al.)

- Theory: routing, clock synchronization



Anypath cost (Dubois-Ferrière et al.)

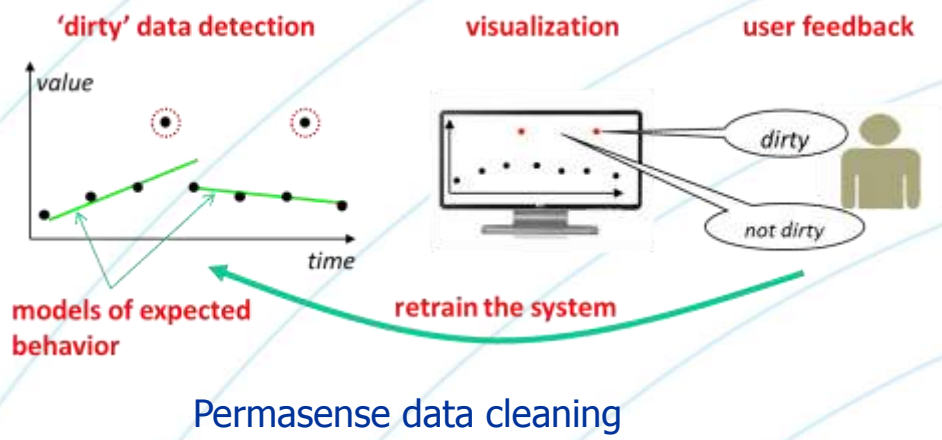


Synchronization bounds (Lenzen et al.)

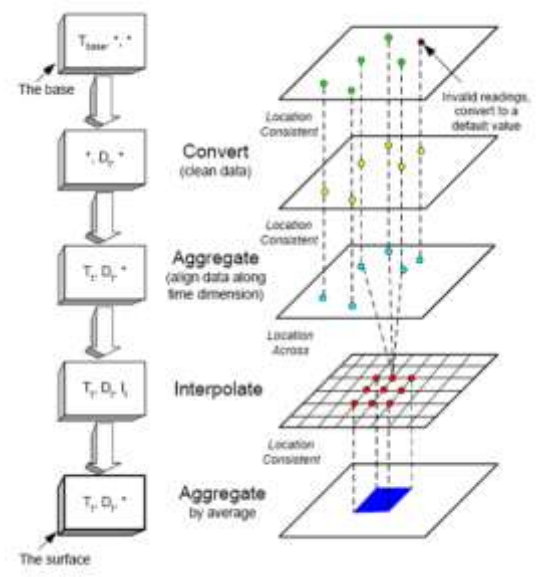
# What was really achieved (2)?

Sep 2012

- A few examples among many
  - Scientific data management



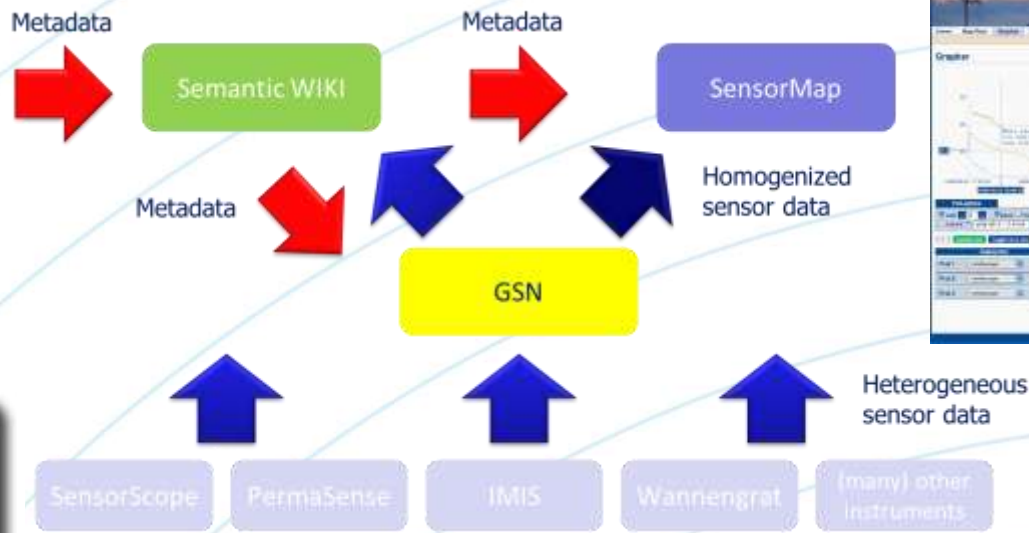
## Data processing workflow



# What was really achieved (3)?

Sep 2012

- Interdisciplinarity: the Swiss Experiment platform



# What was really achieved (4)?

Sep 2012

- Technology transfer: the Spin Fund program



NCCR MICS  
National Competence  
Center in Research  
Mobile Information and  
Communication Systems

create  
value  
out of  
your  
research

12 months  
salary paid  
to prepare  
your start-up  
or intellectual  
property business

MICS •  
spin  
fund

[www.mics.org/spinfund](http://www.mics.org/spinfund)

## What could we have done better?

- Berkeley spirit...
  - Working together is more than the sum of its parts
  - Going after (even) more ambitious projects
- One hot shot startup
  - We have a number of great start-ups
  - But do we have a google/foursquare/etc in the making?
- Ambitious publications!
  - MICS publications are great!
  - But do we have high impact journal publication about the project (part of larger problem)
- Galileo invents the microscope
  - And finds the law of the universe
  - We have great new instruments
  - Can we get some great new understanding?

## Great achievements of MICS!

- The h factor of MICS ;)
  - Approximately 106!
  - Pretty good for something only a decade old
- Academic impact
  - Close to 300 PhDs
  - 34 academics from the ranks of MICS PhD students
- Industrial impact
  - Companies in industrial liaison program (all the players are there)
  - Collaborations ongoing!

## Great achievements of MICS!

- Start-up impact
  - A good number of small and medium companies spun off
  - Spinfund is an excellent model

### Mike Stonebreaker

- I like to see my ideas make the light of day. If you just publish papers at a university, it's likely that no technology transfer will happen.
  - If you approach a large company with your idea, the chances of it getting picked up aren't high.
  - The best way to see your idea through is a start-up. I specialize in disruptive tech. Start-ups are great for that!.
- Great new projects!
    - Continuations, momentum, collaborations



## What does it mean for academia ?

Interdisciplinary work is hard work

- I would not recommend it to get tenure!
- Traditional departments have a hard time

Large centers are not easy to handle on campuses

- NCCR
- SNF
- Tenure
- Academic policy

It is all about governance!

# What does it mean for academic research ?

H.Poincaré:

“What is mathematical creation? It does not consist in making new combinations with mathematical entities already known. Any one could do that, but the combinations so made would be infinite in number and most of them absolutely without interest...”

“Among chosen combinations the most fertile will often be those formed of elements drawn from domains which are far apart. .... But certain among them, very rare, are the most fruitful of all.”

The action is at the boundaries

- It is fun (remember Val Ferret!)
- But it takes a long time
- And it is not easy to communicate and align interests

But is where a lot of future research gets created!

## What does it mean for SNF ?

The 800 Million dollar question!

- Directed versus free research

Directed research is popular...

- With politicians
- With the public

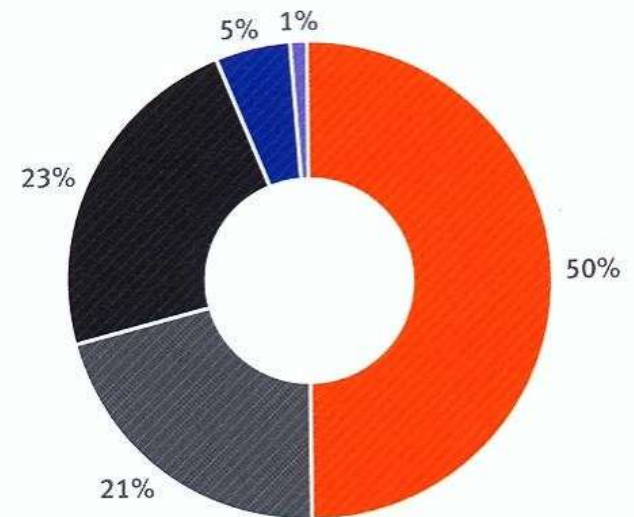
What do researchers want?

- How to have max impact!

What do I think ;)

- Provoque a phase transition!

Répartition des montants accordés



- Projets
- Carrières
- Programmes
- Infrastructures
- Communication scientifique

## Information-Computation-Communication

- The magic triangle!

## DNA of the field

- What are core competences?
  - Tools for the trade, education
- What are the fundamental questions?
  - The long view
- What are the killer apps?
  - Drivers for innovation and new questions
- What is the style and the culture?
  - Methods, data, approach, results

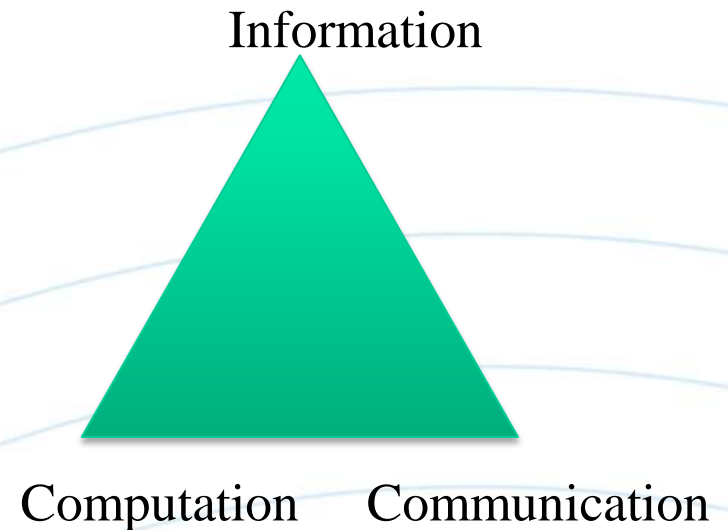


Figure 1 of [Shannon:1948]



The long view...

- According to an apocryphal story, Werner Heisenberg was asked what he would ask God, given the opportunity. His reply was: "When I meet God, I am going to ask him two questions: Why relativity? And why turbulence? I really believe he will have an answer for the first."

So, what would have Turing and Shannon asked?

- P versus NP?
- Is the universe a computer?
- What is consciousness?



Thank you for your attention!