

# Quality of Experience in Communications Ecosystems

Kalevi Kilkki

Aalto University

Espoo, Finland

**8 December 2010**

# Agenda

- Communications Ecosystem
- From QoS to QoE
- Relationship with business
- Conclusion

# Communications Ecosystem

# Communications Ecosystem = ?

## » Communications

- the science and technology of communicating, especially by electronic means (note: plural only)

## » Ecosystem

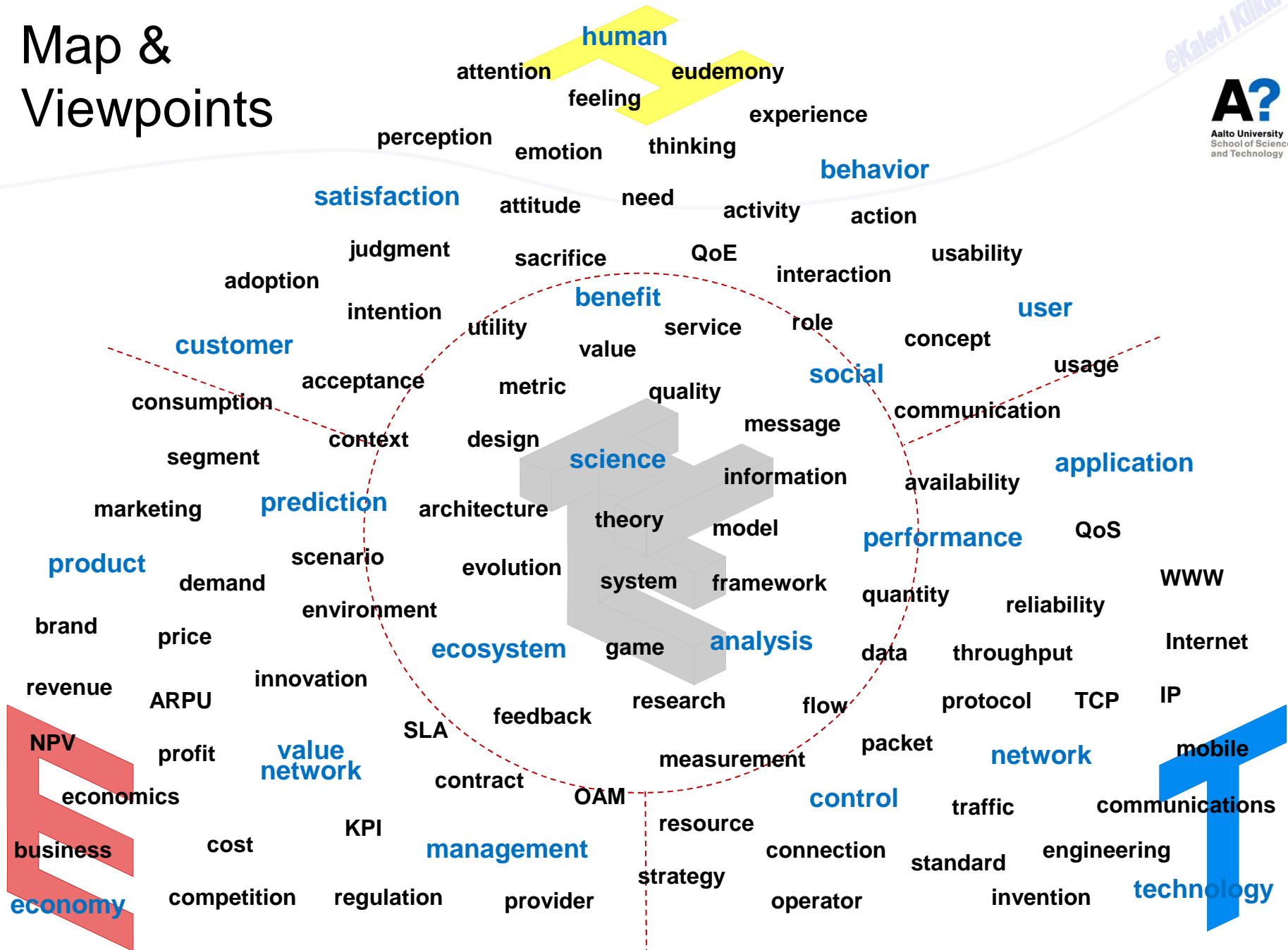
- a community of organisms together with their environment, viewed as a system of interacting and interdependent relationships
  - More terms in Communications Ecosystem Dictionary at <http://kilkki.net/3>

## » Combination of 4 domains

- Human, Economic, Technical, Systemic

# Map & Viewpoints

©Kalevi Kulkki



# Different objectives

Domain	Driving force	Metrics
Human	Need*	Eudemony** (happiness)
Economic	Demand***	Profit (money)
Technical (communications)	Requirements	Throughput (capabilities)

\* a physiological or psychological necessity for the well-being of an organism

\*\* a measure of the more preferred state of affairs

\*\*\* willingness and ability to purchase a good or service

QoS  $\Rightarrow$  QoE

# Quality of Service

- » A lot of confusion both with *quality* and *service*
- » QoS according to ITU
  - "A set of quality **requirements** on the collective behavior of one or more objects"

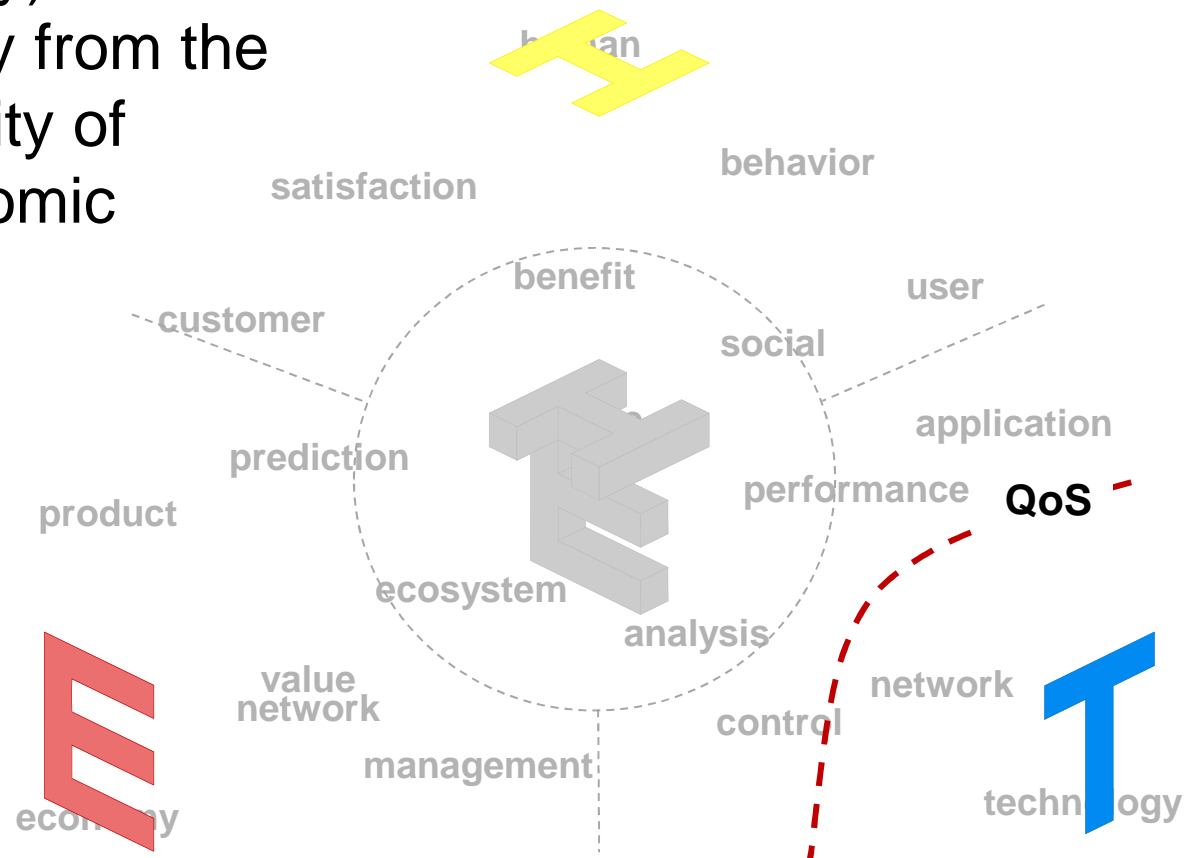
- "the collective effect of service performances which determine the degree of satisfaction of a user of the service"



# Thesis

- » *Requirements* have been used (successfully) to isolate technology from the extreme complexity of human and economic domains

- » **BUT**
  - in case of QoS this approach does not work



# Key words in IEEE database\*

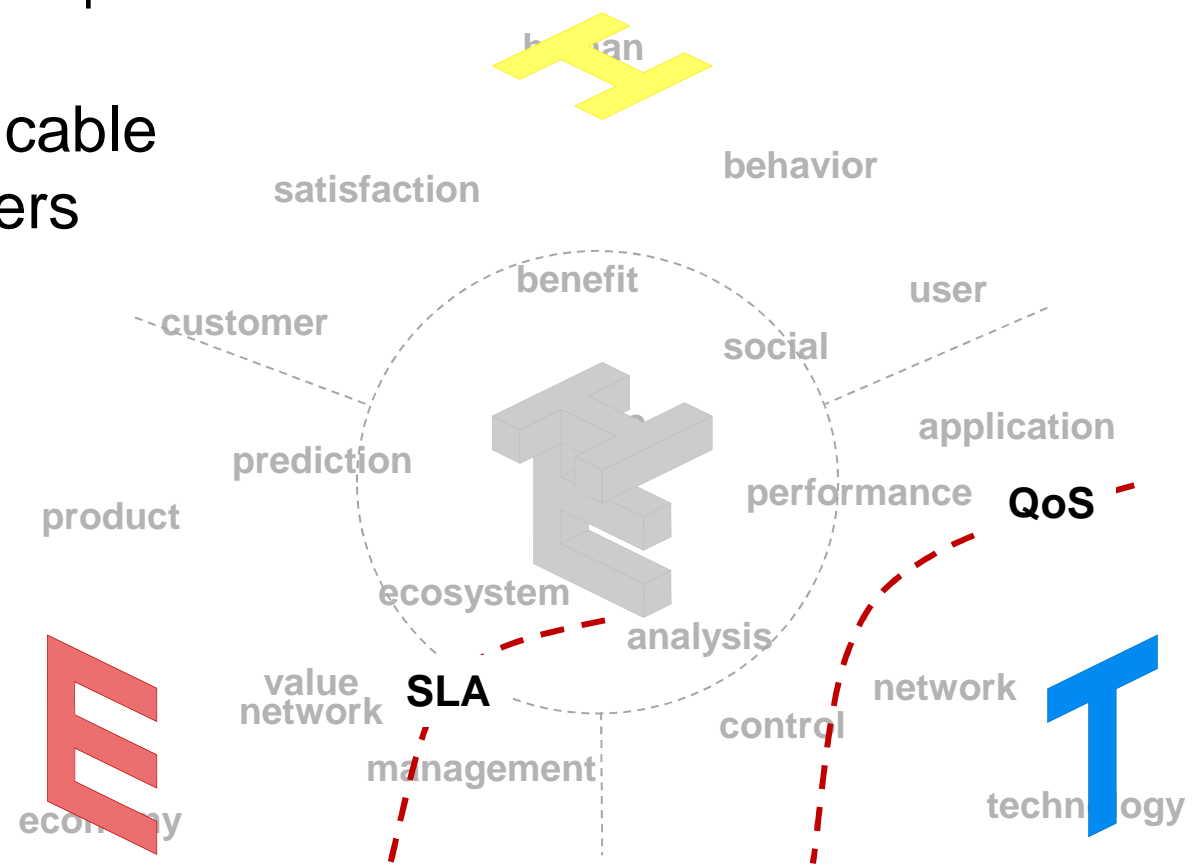
Journal or conference papers with the term in abstract

Term	1996-98	1999-2001	2002-04	2005-07	2008-2010
Network	20397	23420	33229	43187	92120
<b>Quality of Service</b>	1025	1585	2362	2627	4003
Network performance	250	281	430	575	1465
<b>Service Level Agreement</b>	1	39	116	204	134
Mean Opinion Score	28	36	58	52	102
<b>Quality of Experience</b>	2	2	6	16	230
Business objective	7	13	7	24	4
Customer churn	0	2	4	5	34
Key Performance Indicator	0	0	0	8	18
Average Revenue per User	0	0	3	4	8
Hierarchy of needs	0	0	1	3	7

\* <http://ieeexplore.ieee.org/>

# Solution?

- » Service Level Agreement
  - works between enterprises
  
- » but is hardly applicable with individual users
  - too complex
  - too rigid
  - too economic



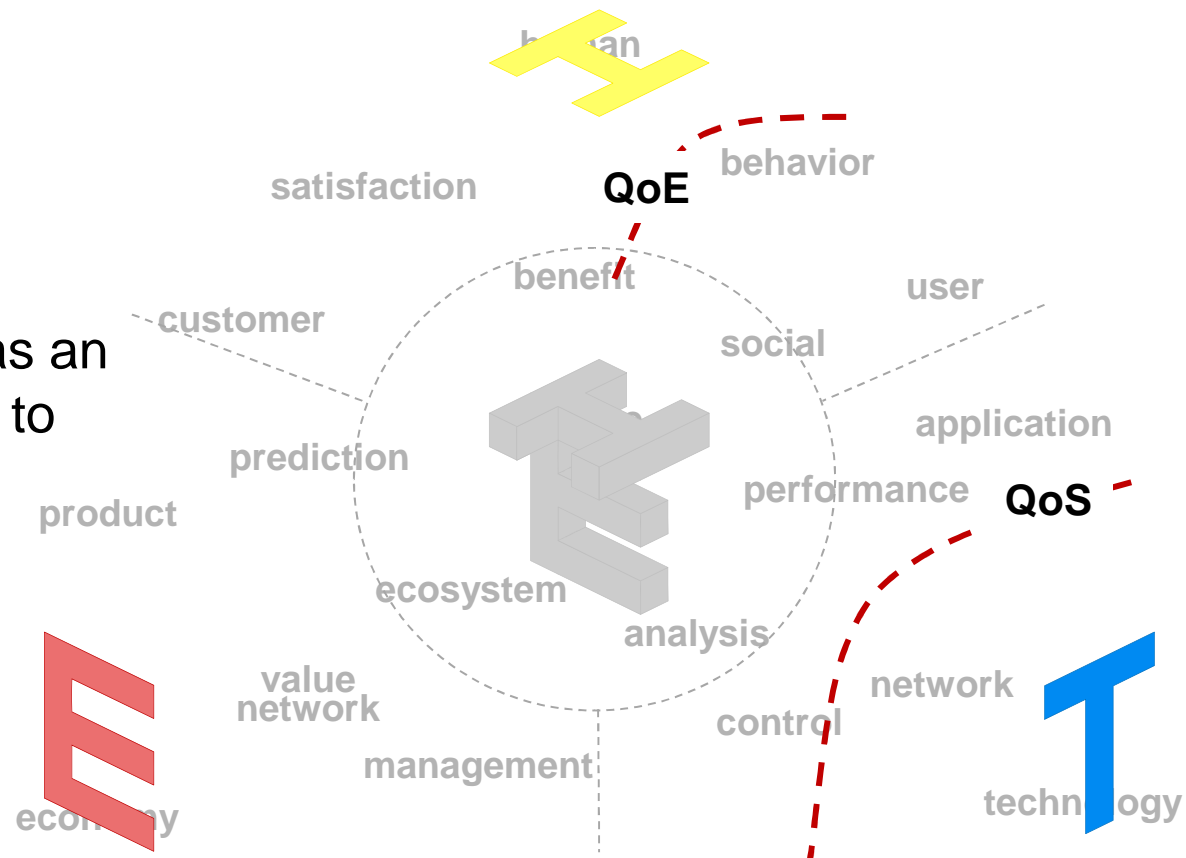
# 2<sup>nd</sup> Solution?

## » Quality of Experience

- individual perspective to the quality of a service?

## » But

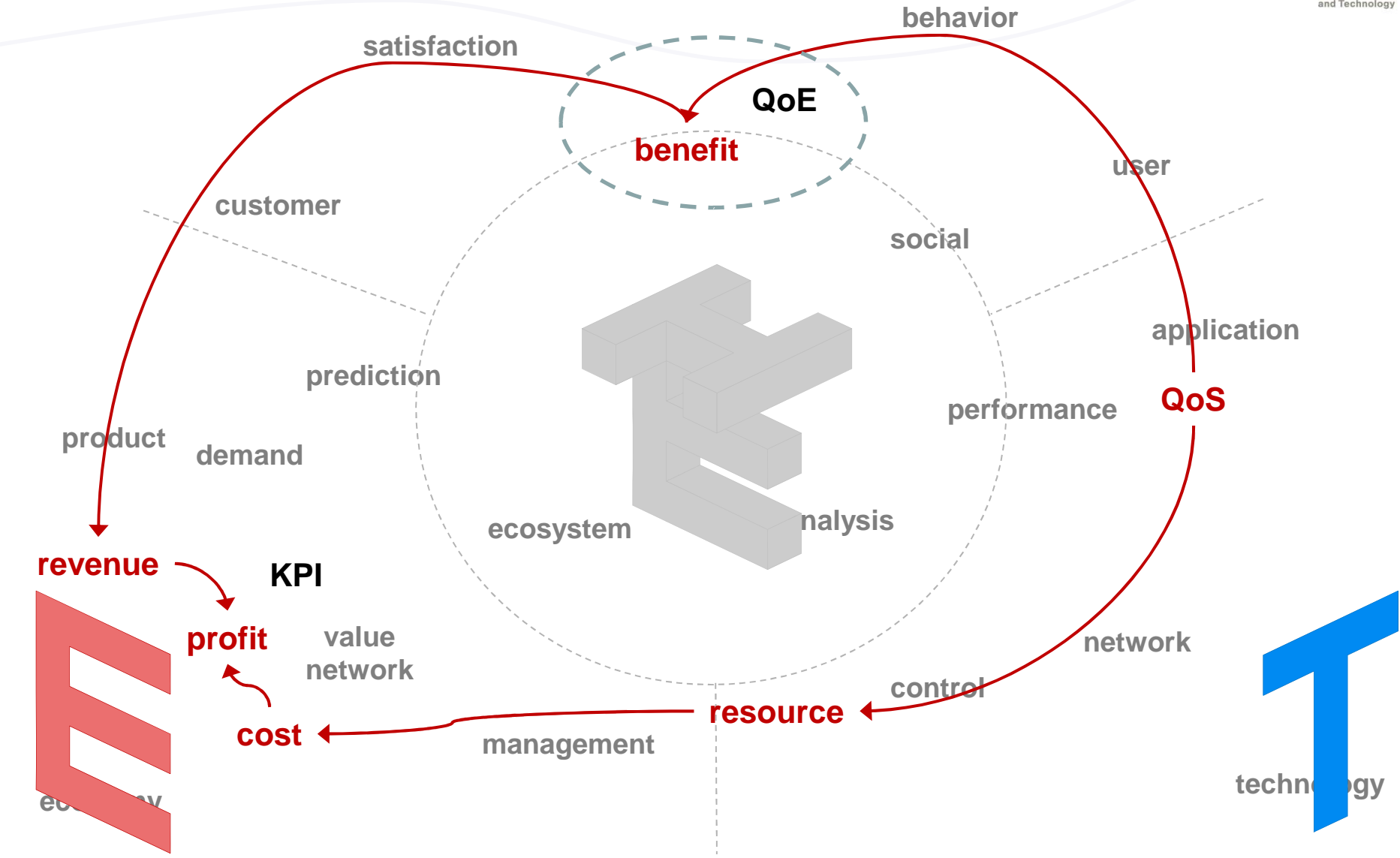
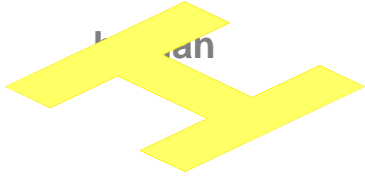
- to interpret QoE as an extension of QoS to human domain is problematic
  - too far
  - different languages and metrics



# Quality of Experience

- » QoS has been a technical concept
  - let us keep it as it is
    - delay, packet loss ratio, etc.
  
- » QoE
  - a deeply human concept
    - difficult (maybe impossible) to parameterize
  - a set of inherent attributes of the content of direct observation or participation in an event

# Business



# Research Agenda

## » Models needed

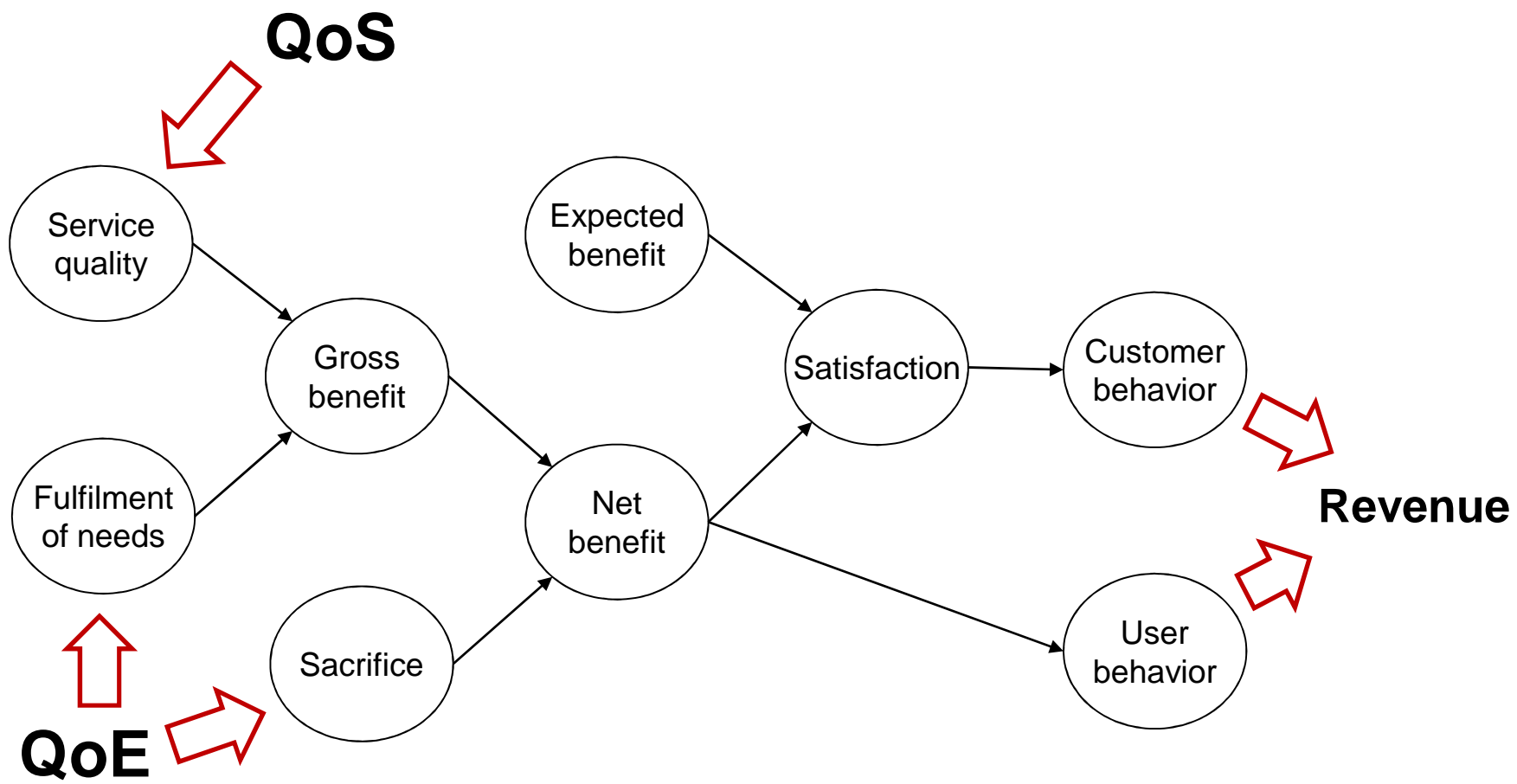
1. How QoS (of network services) affect applications' performance
2. How users react to the changes in applications' performance
3. How much users benefit from the usage of applications
4. What are the sacrifices users need to pay for when using applications
  - price, effort, value of time, etc.
5. How satisfied customer will be for given experience
6. How customers select different products and services



**QoE**



# Part of the modeling chain



# Modeling challenges

- » Inherent feedback loops
  - QoS  $\Rightarrow$  user behavior  $\Rightarrow$  traffic demand  $\Rightarrow$  QoS
  - Service providers react to actions of other providers
  - Etc.
  
- » Cost analysis (techno-economic modeling)
  - Laborious, but relatively straightforward
  
- » Integration of models is a hard challenge
  - But possible if we limit the complexity of separate models

# Conclusion

- » QoS and QoE are integral parts of the communications ecosystem
  - QoS in the technical domain
  - QoE in the human domain
  
- » Let us keep them clearly separate

