Economics of QoE in the Future

Internet of People (IoP)

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Basic Framework

- **Starting point**: rapid evolution of IoT vs cyber-physical convergence
  → integration of physical and cyber world

- **Consequence**:
  - humans are placed right at the centre of the technical systems they use
  - resulting paradigm change: Anti-Copernican Revolution

- **Main resulting scenarios**:
  - “Human proxy”: communication between devices acting as proxies
  - “Crowdsourcing”: exploiting human resources for optimal system operation
  - “User Experience”: behavior of devices is designed taking user reaction

- **This talk**: economics of QoE in the resulting “Internet of People” (IoP)?

Source: [Conti, Passarella et al. 2012]

Source: [Reichl&Passarella 2015]
From Charging for QoS to Charging for QoE

- Simple (but instructive) quality model:

- **Characterization by set of functions:**
  - *Price function* \( p = p(q) \) \( \rightarrow \) \( p = p(x) \)
  - *Demand function* \( d = d(p) \) \( \rightarrow \) \( d = d(p,x) \)
  - *QoS function* \( q = q(d) \)
  - *QoE function* \( x = x(q,p;\Omega) \)

- **Wanted:** fixed point solutions (existence, characteristics)

[Reichl et al. 2013]
### Price-Sensitive vs Quality-Sensitive Case

- **Key result** (under rather mild conditions):
  - QoS case: two (trivial) fixed points
    - excellent QoS at high price (stable)
    - bad QoS for free (unstable)
  - QoE case: one (non-trivial) fixed point
    - tradeoff between charge/tariff and expected user QoE
  - Integrated model for price-sensitive vs quality-sensitive case

[Reichl, Maillé, Zwickl, Sackl 2013]
Validation: ETICS User Trials

- **Idea:** investigate the purchase of quality levels based on realtime HD video streams with different bit rates under logarithmic spacing (direct influence on TCP streams)

- **Approach:**
  - 20 quality levels, prices between 0 and 2/3/4 €
  - users receive 10€ in cash which can be spent on quality

- **Test setup:**

[Sackl, Zwickl, Reichl 2013]
Some Trial Results

- Distribution of payments
  ![Distribution of payments chart]
  *[Sackl et al. 2012]*

- Price/quality changes (per movie)
  ![Price/quality changes chart]
  *[Sackl et al. 2012]*

- User convergence behaviour (differences in speed and amplitude)
  ![User convergence behaviour charts]
  *[Reichl et al. 2013]*
Making QoE Work: From SLA to ELA

- QoE as key step in the transition towards future IoP
  - however: focus so far on modeling, not on operational concerns

- Current situation:
  - network services sold as best-effort (usually flat rate)
  - “race to the bottom” on pricing
  - but: users are willing to pay for quality

- Wanted: agreed upon understanding of service performance targets
  → KPIs, metrics, penalties for non-compliance

- Idea: ELA (Experience Level Agreement) = special type of SLA which is
  - designed to establish a common understanding of the quality levels that
    the customer will experience through the use of the service
  - in terms that are clearly understandable to the customer and to which he
    or she can relate.

- Note: QoS : QoE = SLA : ELA → basic complementarity
What have we learned

- Future Internet: “brave new world” vs “collateral benefit”?
- Arrival of IoT as potential game changer
- Vision of cyber-physical convergence: Anti-Copernican Revolution
- Resulting interdisciplinary approach
- Example: QoE and its economics
- Don’t forget the operational side: from SLA to ELA
- The “Internet of People” (IoP) as an “Internet for People” (I4P)
References and Further Reading


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Thanks for your attention!
Any feedback highly welcome!