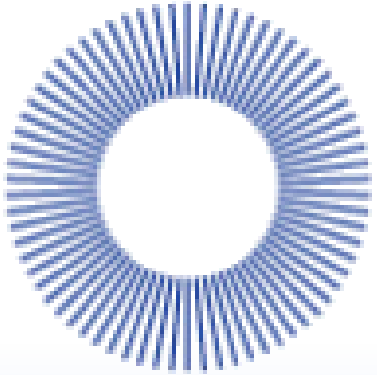
# Estimating Customer QoE from Network Metrics

## QoS to QoE

Kenneth Nagin, Andre Kasiss, **Dean Lorenz**
Kathy Barabash, Eran Raichstein



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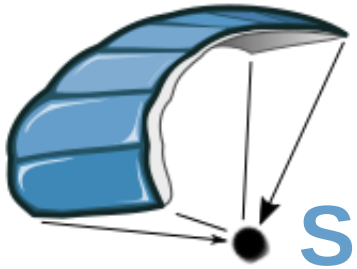

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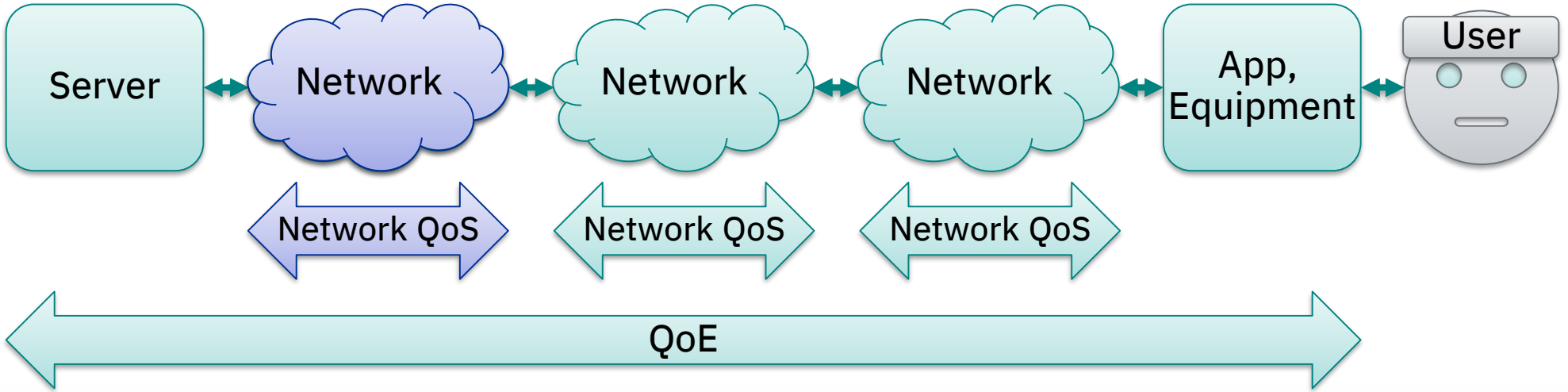
# QoE – Quality of Experience

## Measure of User Satisfaction

- User centric, service specific, context dependent
- Measured with end-user feedback
- An end-to-end metric
  - Network QoS is only part of the story





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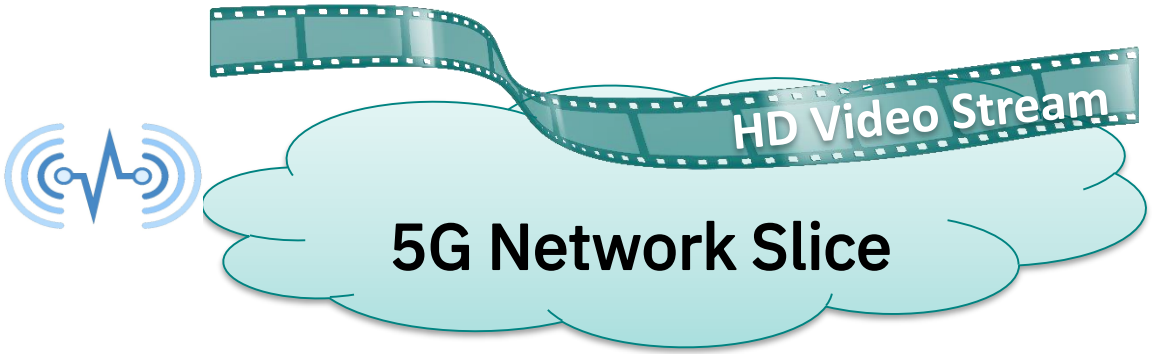
# Example: SliceNet eHealth Use-Case






- Use Case:
  - Paramedic streams live HD video feed from ambulance to hospital
  - Hospital personnel advise paramedics on actions to take
- QoE:
  - Quality of video experience
  - May be influenced by:
    - Scenario, e.g., conf call vs. diagnosis
    - Equipment, e.g., size/quality of screen
    - Mobility, weather, eyesight, time-to-live



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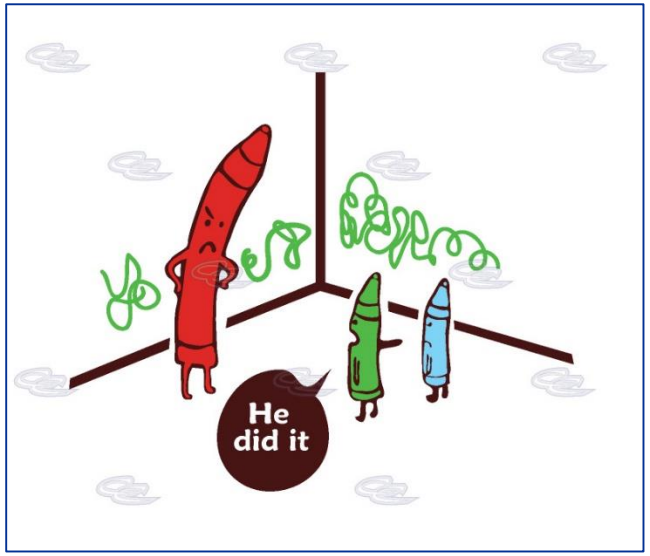
# Why Estimate QoE?



- Meet SLA
  - Minimize  QoS without degrading QoE (save $)
    - SLA usually defined by QoS
- Exceed SLA to achieve QoE
  - Compensate for poor QoS by other components
    - Think Earliest-Due-Date (EDD) scheduling
  - Can be value add, pay-per-use, best-effort
- Shift blame if something goes wrong
  - Log proof of QoS (audit) when QoE is poor
  - Collect more info
- Notify service owner
  - Throttle / apologize to users / degrade gracefully
  - Change service parameters, mask degradation





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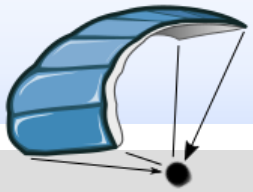
# Problem Definition: QoS → QoE





- **Input**: measured QoS
  - Metrics, any available indicators
  - Partial view
- **Output**: estimated QoE

Flows

| App. | A | B | AB Pkts | BA Pkts | AB Bytes | BA Bytes | RTT ms |
|---|---|---|---|---|---|---|---|
| DNS | 10.186.164.173 | 10.0.80.11 | 1 | 1 | 82 | 98 | 0.512 |
| DNS | 10.186.164.173 | 10.0.80.11 | 1 | 1 | 82 | 98 | 0.521 |
| DNS | 10.186.164.173 | 10.0.80.11 | 1 | 1 | 82 | 98 | 0.417 |
| DNS | 10.186.164.173 | 10.0.80.11 | 1 | 1 | 82 | 98 | 0.481 |

- Follow-up question: where is the problem?
  - Network provider perspective:
    - Network problem → *fix*
    - Not network problem → *notify*
  - Service provider perspective:
    - Network problem → *complain*
    - Service problem → *fix*
    - Other → *notify*

Can you guess the QoE?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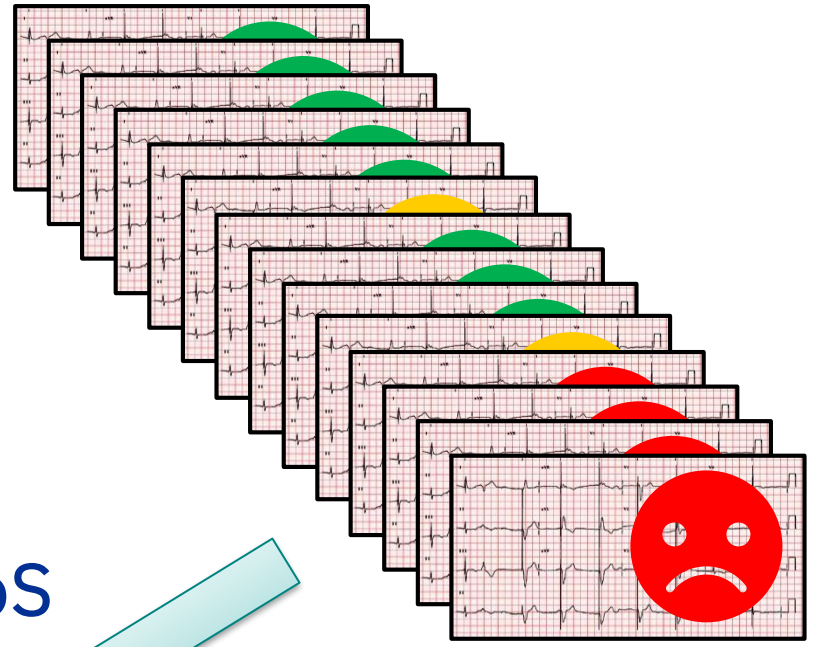
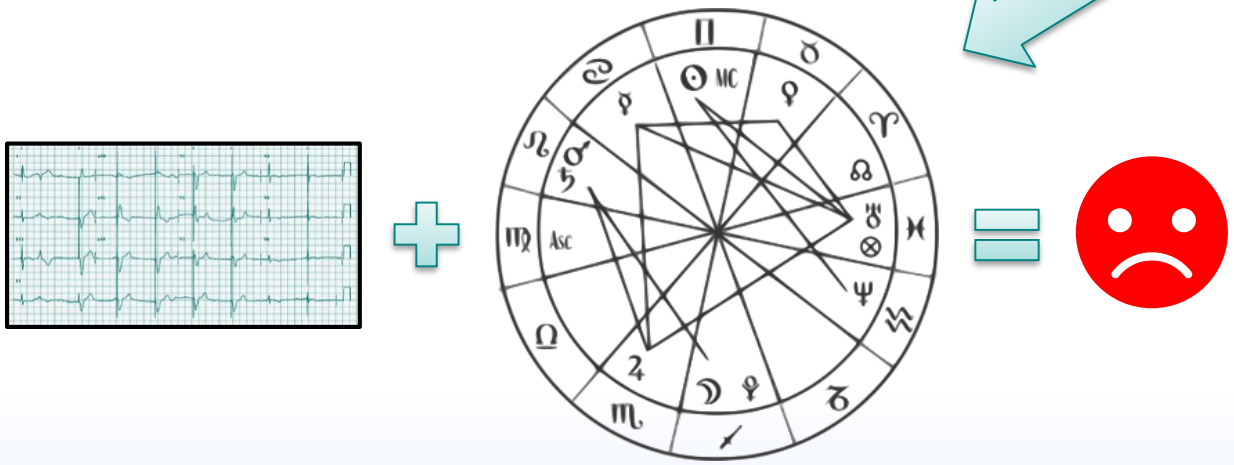
# Solution Outline: Machine Learning Approach



## Other approaches apply too

- **Model Training:**
  - Measured QoS
  - QoE labels
- **Output:** QoE Estimator
- **Usage:** apply model on measured QoS



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# Validation: Actual QoE vs. Estimation

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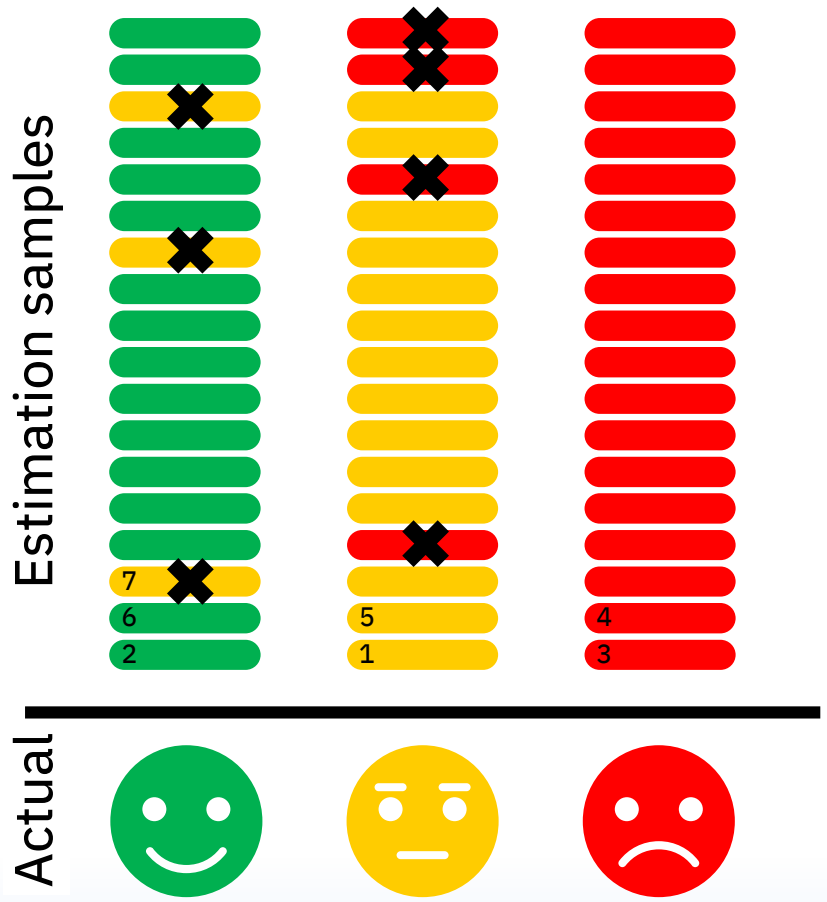
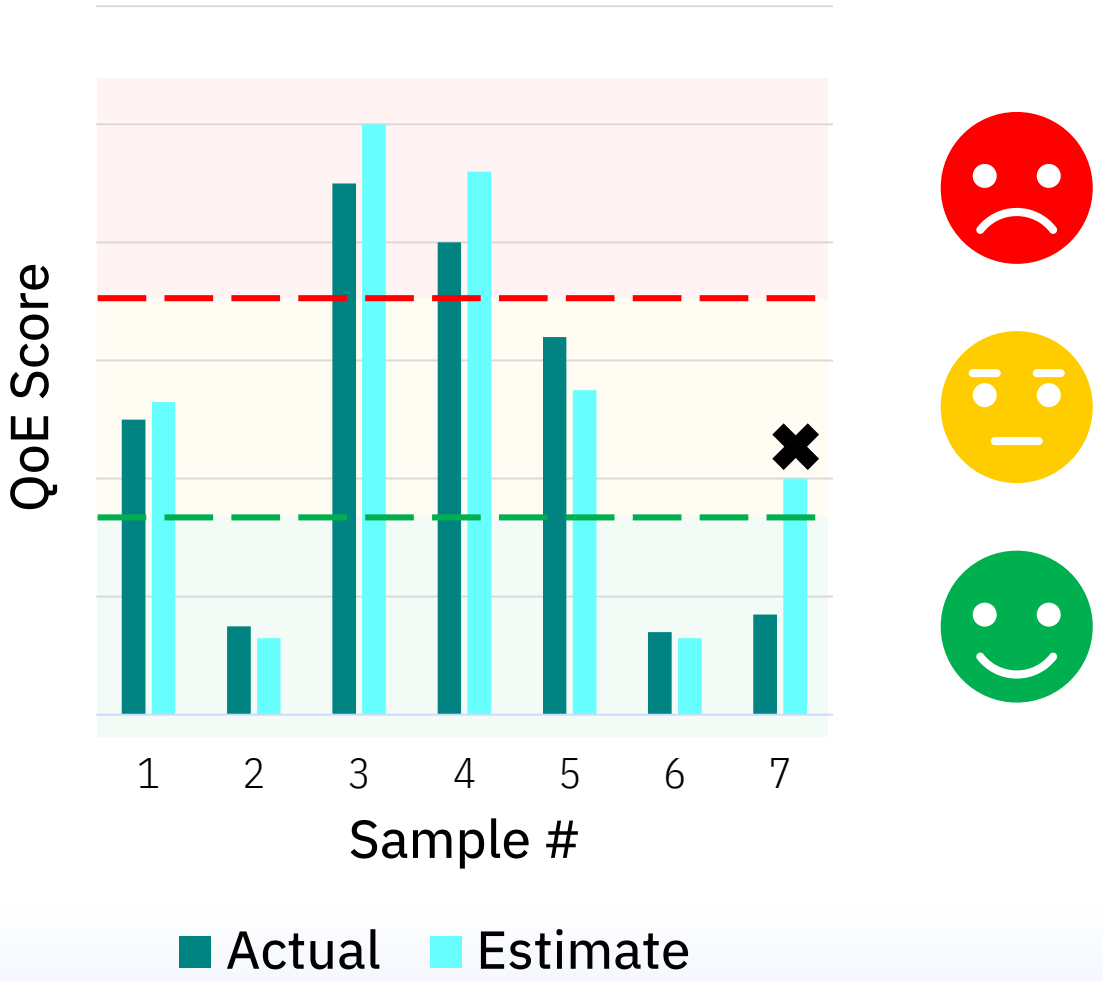
## Missed Estimations




## QoE Score





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# Thank you!

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## Dean Lorenz

### IBM Research – Haifa

dean@il.ibm.com

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