INF Informatik

Hochschule Reutlingen

IoT Sustainability / ELSI

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AGENDA

- What is ELSI/ELSA (Ethical, Legal and Social Issues/Aspects) and what are the implications for IoT?
- What is sustainability and what are the implications for IoT?

ELSI

- **Origins of ELSI**
  - Coined in genomics research (Human Genome Project)
  - Framework to spot Ethical, Legal, and Social Implications early
- **Extending to Digital Tech**
  - New technologies often outpace policy and public awareness
  - IoT exemplifies rapid diffusion into everyday life
- **Why It Matters Now**
  - Billions of connected devices by 2025 collecting personal and environmental data
  - Decisions by algorithms can affect safety, privacy, and social equity
  - Without ELSI foresight, unintended harms (surveillance, discrimination, environmental damage) can proliferate

ETHICAL PILLAR IN IOT

- **Privacy & Informed Consent**
  - Can users meaningfully consent if devices “always listen” or “always track”?
  - Data minimization: only collect what is strictly necessary
- **Autonomy & Transparency**
  - How do we ensure users control their own data and device behavior?
  - Algorithmic transparency: “Why did my thermostat lower the temperature?”
- **Fairness & Bias**
  - Data-driven decisions (e.g., health alerts) may privilege some groups over others
  - Surveillance-driven harms: profiling by income, race, or health status
- **Trust & Accountability**
  - Manufacturers must build trust through clear policies and robust security
  - Who is responsible when an AI-driven device makes a harmful decision?

LEGAL PILLAR IN IOT

- **Data Protection (e.g., GDPR)**
- Personal data vs. special-category data (health metrics, location traces)
- Key GDPR Articles
  - Art. 5: Principles (purpose limitation, data minimization, storage limitation)
  - Art. 6: Lawful basis (consent, legitimate interest)
  - Art. 25: Data Protection by Design & by Default
- Rights: access, rectification, erasure, portability
- **Consumer Protection & Product Liability**
- Reasonable expectations of safety and accuracy
- Liability when an IoT device malfunctions or is exploited by hackers
- **Sector-Specific Regulations**
- Medical Devices Regulation (MDR) for wearables that collect health data
- Automotive rules (e.g., UNECE WP.29 cybersecurity requirements for connected cars)
- Smart meter directives (ePrivacy, energy regulation)

SOCIAL PILLAR IN IOT

- **Digital Divide & Equity**
  - Who can afford and access IoT technologies?
  - Rural vs. urban deployment of smart-city infrastructure
- **Cultural & Social Acceptance**
  - Varying attitudes toward surveillance: convenience vs. distrust
  - Social norms about recording audio/video in private/public spaces
- **Environmental Impact**
  - E-waste: short device lifecycles, non-recyclable components
  - Energy consumption: always-online sensors draw continuous power
  - Rebound effect: energy monitoring → lower bills → higher usage
- **Social Justice Concerns**
  - Smart-city data used to profile neighborhoods → gentrification pressures
  - Workplace wearables: employer access to health/fitness data → discrimination risks

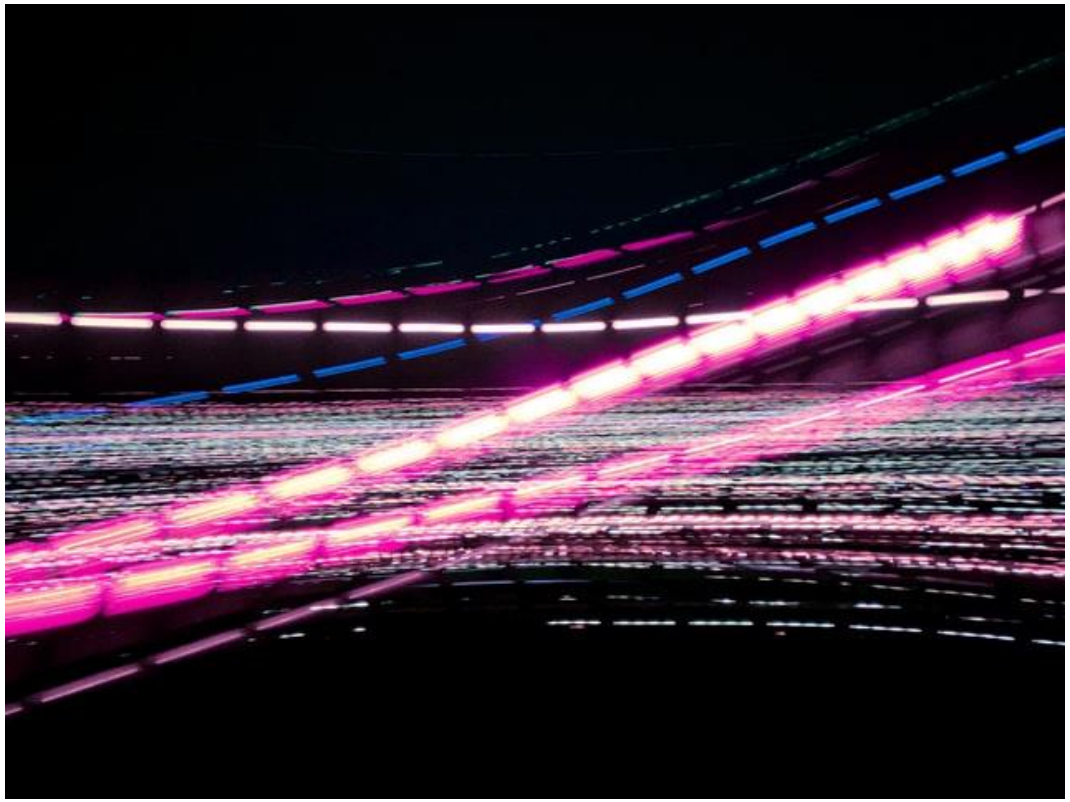
ELSI-SAT LITE

- **Overview of ELSI-SAT**
- Self-Assessment Tool originally for genomics → adapted for emerging tech
- Structured checklist to identify Ethical, Legal, Social issues early in design
- **Four Quadrants**

1. **Stakeholders**
    1. Who is involved or impacted? (Manufacturers, users, regulators, third-parties)
2. **Data Flows**
    1. What data is collected? How is it processed, stored, shared? Who has access?
3. **Risks & Consequences**
    1. Privacy violations, security breaches, liability, social harms
4. **Mitigations & Governance**
    1. Technical safeguards, policy measures, contractual agreements, oversight mechanisms

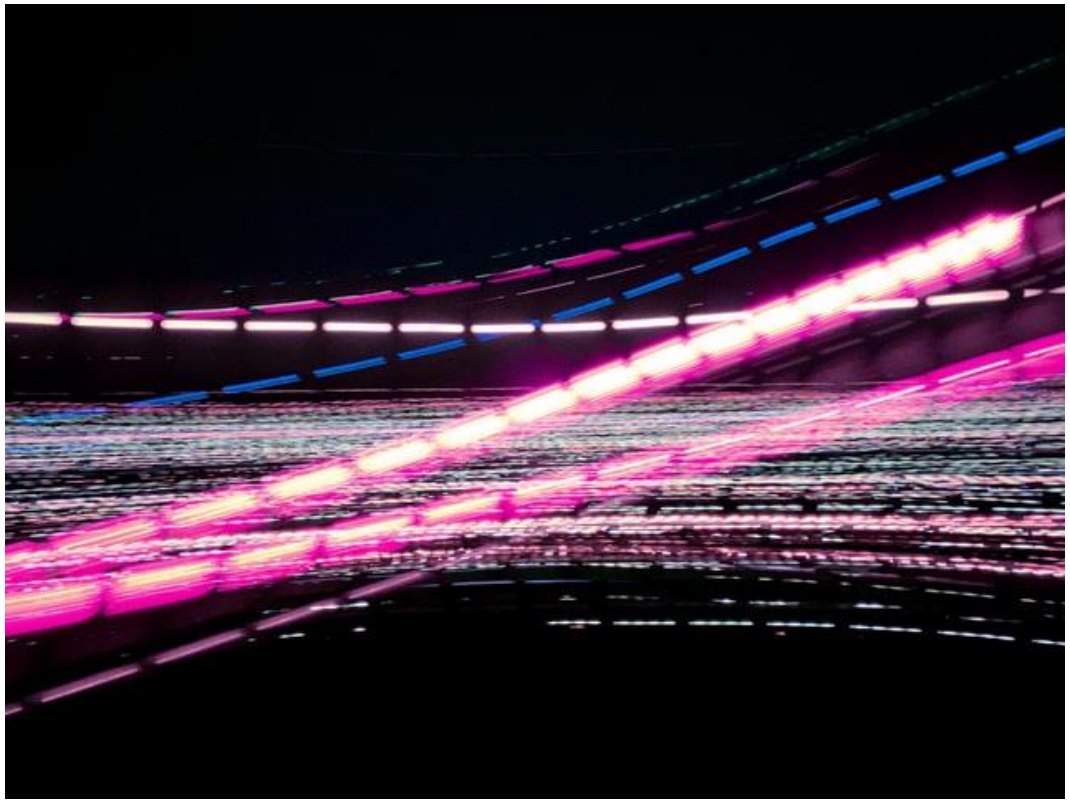
CASE STUDIES: ELSI SAT FOR IOT

- For each scenario, provide:
  - Stakeholders
  - Data flows
  - ELSI focus points regarding
    - Ethical
    - Legal
    - Social



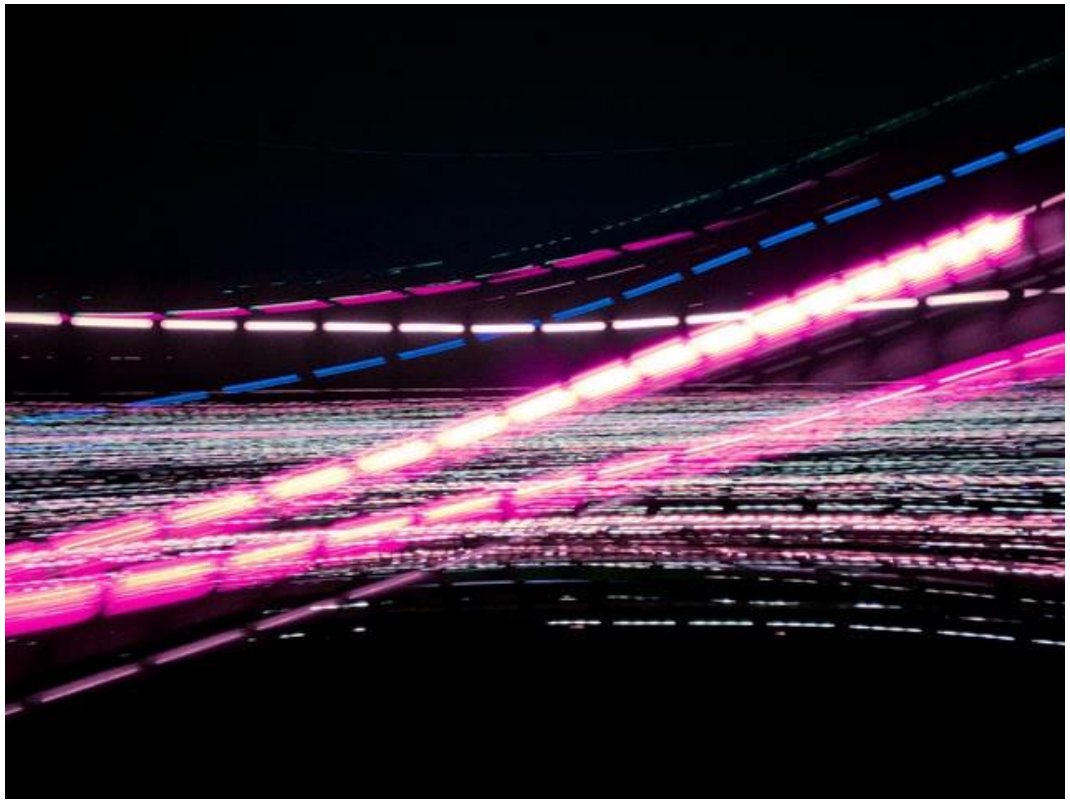
CASE STUDIES: ELSI SAT FOR IOT

- Smart Home Doorbell Camera
  - A popular “smart doorbell” device (e.g., Ring-style) is installed by homeowners to see and speak with visitors via a mobile app. It uses a built-in HD camera, microphone, motion sensors, and Wi-Fi to stream live video/audio to cloud servers. Users can share recorded clips with neighbors or law enforcement.
- Wearable Health-Monitoring Wristband
  - A health startup releases a wristband that continuously monitors heart rate, blood oxygen (SpO_2), sleep stages, and step count. Data syncs via Bluetooth to a smartphone app, then uploads aggregated insights (e.g., “stress alerts,” “sleep quality reports”) to the vendor’s cloud. Third-party researchers or insurers may request anonymized data for analytics.



CASE STUDIES: ELSI SAT FOR IOT

- Industrial IoT in a “Smart Factory”
  - A mid-sized manufacturing plant installs a network of IoT sensors on its assembly line: vibration sensors on motors, temperature/humidity sensors in storage areas, and RFID tags on parts. Data is streamed to an on-premises edge server which triggers automated alerts (e.g., “Motor 3 overheating”) and logs production metrics. A cloud dashboard provides real-time KPIs to management and remote engineers.
- City-Wide Air-Quality Sensor Network
  - A mid-sized European city deploys 100 IoT air-quality sensors on streetlights to measure particulate matter ($PM_{2.5}$), NO_2, and CO levels. Data is publicly accessible via a municipal website and a mobile app, aiming to inform citizens and guide policy (e.g., traffic restrictions on high-pollution days). A private analytics company processes raw data to produce heatmap forecasts of pollution hotspots.



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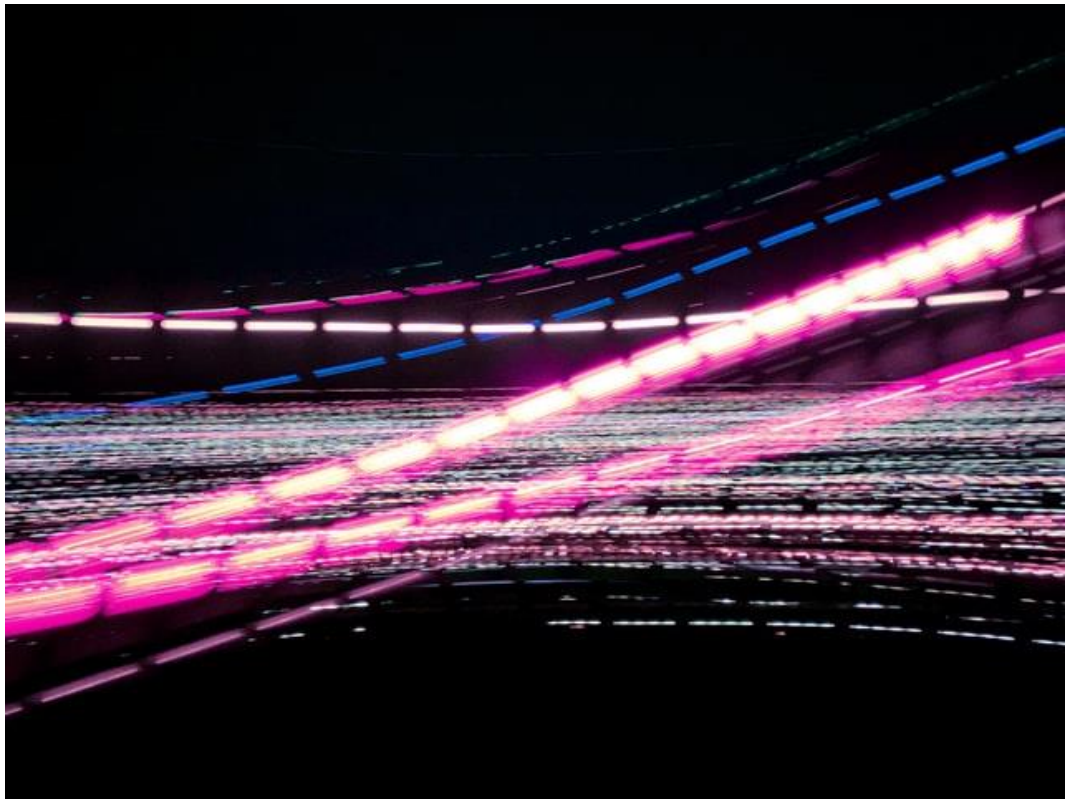
OPEN DISCUSSION: IOT FOR SUSTAINABILITY AND ELSI

- Take some of the UN sustainability goals and see how they affect or are affected by IoT
  - https://sdgs.un.org/goals
- Consider how ELSI aspects intersect / overlap with sustainability issues:
  - Ethics
  - Legal
  - Social
  - And what parts of ELSI are not sustainability-related
  - https://blogs.gm.fh-koeln.de/bente/files/2019/06/Questionnaire-ELSI.pdf
  - https://www.elsi-sat-health-and-care.de
- We will work on the same board as last exercise: https://miro.com/app/board/uXjVMGeND_Q=/



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