How to measure the "Greenness" in Green IoT

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OUTLINE

- Introduction
- Measuring the Greenness of Green IoT
- Test Strategy
- Effective Measurement of Greenness
- Metrics for Measuring Greenness
- Call to Action

EVERYTHING WILL BE CONNECTED TO EVERYTHING ELSE

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Yesterday

Today

Tomorrow

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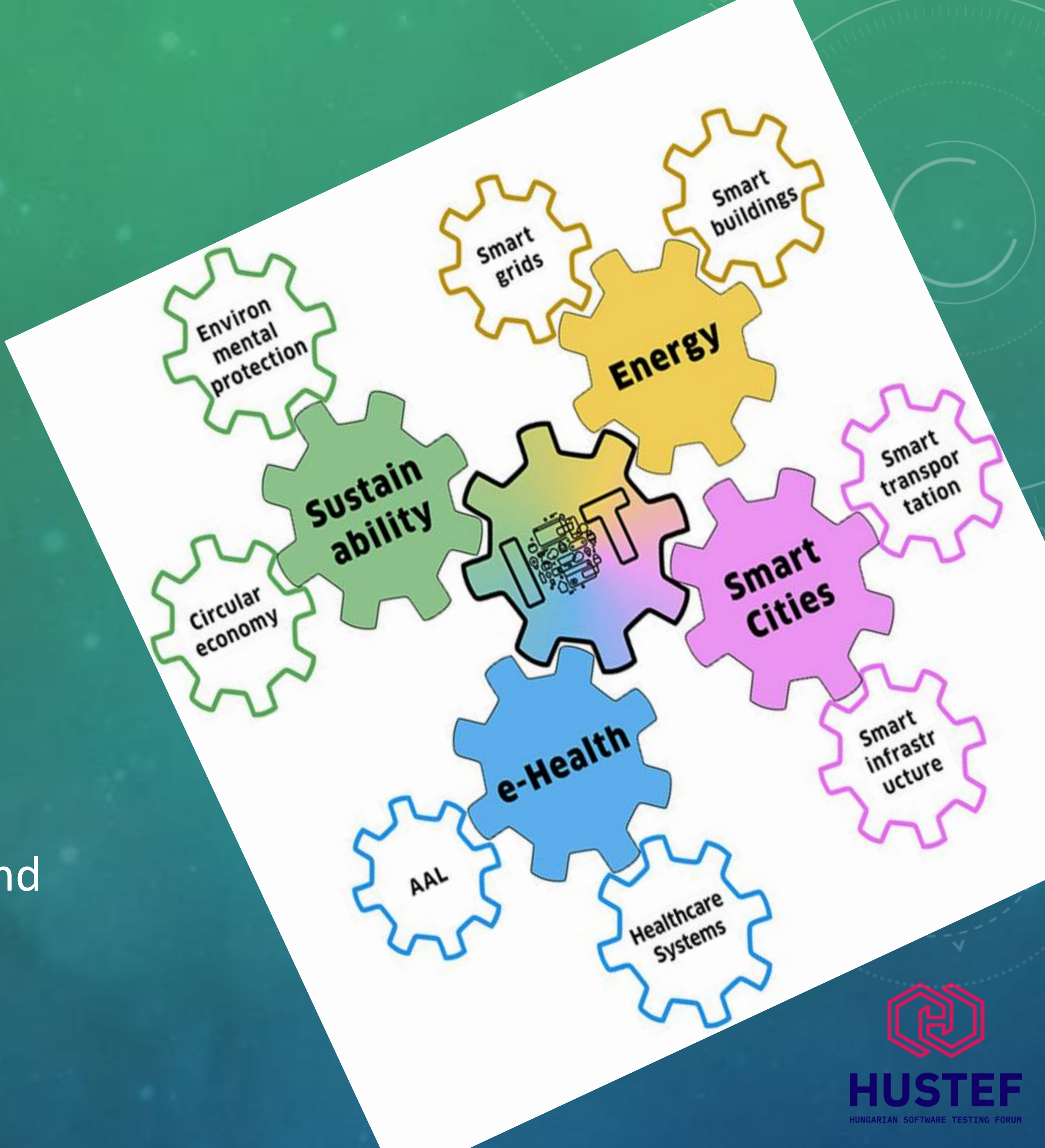
GREEN IoT (G-IoT)

- Sustainable & energy efficient procedures adopted by IoT
- Reduces greenhouse effect of applications
- Developing energy sources for billions of sensors: Solar, Wind, hydro-electric, etc.
- Reduces energy consumption and carbon emission
- Makes world SMART as well as SAFE
- Based on industry-standard technologies and protocols



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GOAL

Effective Test Case Execution to achieve near-zero-defect quality software

REQUIRES

- Infrastructure
- Computing resources
- Software
- Hardware components

OUTCOME

Emit carbon footprint in the environment for each of the test case executions

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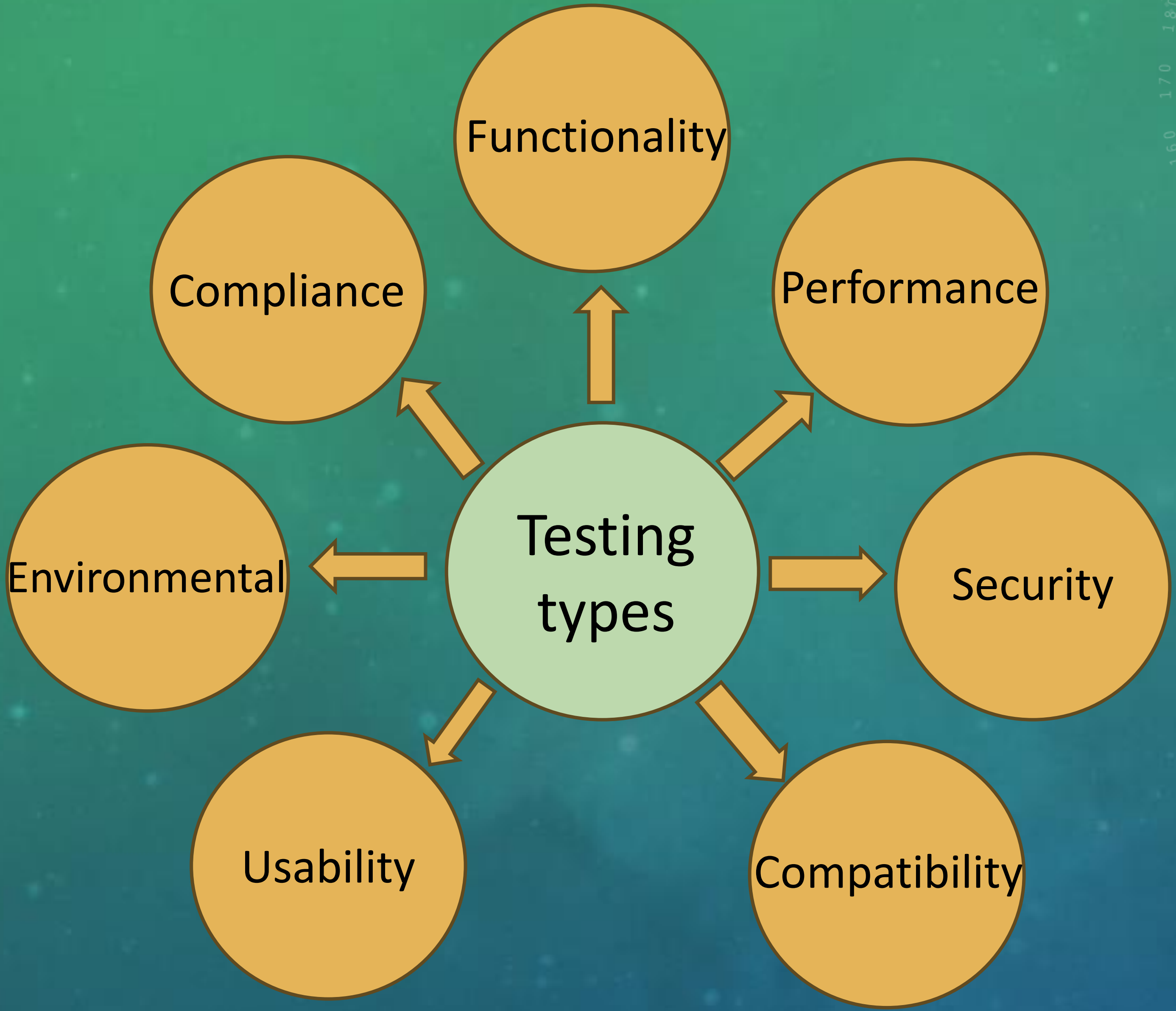
TEST STRATEGY TO TEST THE GREENNESS

- Understand the requirements
- Identify the critical components
- Define the test scope
- Choose appropriate testing techniques
- Develop test cases
- Perform regression testing
- Use testing tools
- Collaborate with stakeholders

MEASURING THE GREENNESS OF GREEN IOT

- Different testing types in the context of measuring greenness
- Test environment and test data requirements
- Metrics for evaluating the effectiveness of Green IoT system in promoting greenness
- Factors to consider:
  - Energy consumption
  - Environmental impact
  - User satisfaction

TESTING TYPES AND TECHNIQUES



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TEST ENVIRONMENT

- A test environment that mimics the production environment of the Green IoT system
- Access to a variety of IoT devices, sensors, and communication protocols
- Emulators or simulators for testing IoT devices that are not available in the test environment
- Network tools to simulate varying levels of network traffic and latency
- Power meters to measure the energy consumption of the system

TEST DATA REQUIREMENTS

- A wide range of test data that covers different scenarios to ensure greenness of the system
- Data that simulates different environmental conditions, such as temperature, humidity, and light levels
- Data that simulates different network conditions, such as varying levels of network traffic and latency
- Data that covers different usage patterns and user behavior
- Data that simulates different hardware and software configurations to test compatibility

KEY PERFORMANCE INDICATORS (KPIS)

- Power consumption
- Network performance
- Environmental conditions
- System performance
- User satisfaction
- Quantifying energy efficiency with Power Usage Effectiveness (PUE) and Energy Efficiency Ratios (EER)
- Monitoring energy consumption of individual components for optimization

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TEST CASES FOR GIOT SYSTEM

Power Consumption Testing

- Verify that the system optimizes the use of sensors and actuators to minimize power consumption
- Verify that the system can be configured to power down when not in use, and can be awakened on demand

Network Testing

- Verify that the system uses energy-efficient communication protocols such as ZigBee or Bluetooth Low Energy (BLE)
- Verify that the system minimizes network traffic by aggregating data and transmitting it in batches

Security Testing

- Verify that the system uses secure communication protocols to protect sensitive data
- Verify that the system uses strong encryption to protect user data

Usability Testing

- Verify that the system is easy to use and understand for end-users
- Verify that the system provides clear feedback to users about their energy consumption

Environmental Testing

- Verify that the system can adjust its energy consumption based on ambient light levels
- Verify that the system can detect and respond to changes in the environment, such as changes in air quality or temperature

Performance Testing

- Verify that the system can process large amounts of data efficiently without consuming excess energy
- Verify that the system can handle multiple devices and sensors without impacting its energy efficiency

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GIOT TEST METRICS

What are the common ones that we should use?

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Energy Consumption

- Average power consumption during idle state
- Energy consumption per data transmission
- Energy consumption per sensor reading
- Total energy consumption per day/week/month

Network Performance

- Data transfer rate
- Packet loss rate
- Average latency
- Network traffic volume

Environment

- Temperature and humidity levels
- Ambient light levels
- Air quality measurements

Usability

- User satisfaction with the system
- Ease of use and understandability of the system
- Effectiveness of the system's feedback and suggestions for reducing energy consumption

Security

- Number of security vulnerabilities detected and resolved
- Time to detect and respond to security threats
- Number of security incidents and their severity

GIOT BUGS

How do they look?

Power Consumption Defects

- High power consumption during idle state or while in use
- Inefficient use of sensors and actuators leading to excess power consumption
- Failure to switch to low-power modes when running on batteries

Network Defects

- Use of energy-intensive communication protocols
- Inefficient transmission of data packets leading to excess energy consumption
- Failure to compress data packets to reduce their size

Usability Defects

- Poor user interface design leading to confusion and difficulty using the system
- Inadequate feedback and suggestions for reducing energy consumption

Environmental Defects

- Inability to operate under different temperature and humidity conditions without consuming excess energy
- Inability to adjust energy consumption based on ambient light levels
- Failure to detect and respond to changes in the environment

Performance Defects

- Slow response time to user input
- Inefficient processing of large amounts of data leading to excess energy consumption
- Inability to handle multiple devices and sensors without impacting energy efficiency

Security Defects

- Use of insecure communication protocols leading to unauthorized access or data breaches
- Weak encryption leading to data leaks

CALL TO ACTION

- Measure power consumption
- Evaluate energy harvesting
- Test network efficiency
- Assess the device lifecycle impact
- Assess the system's carbon footprint
- Verify compliance with standards

GO GREEN

There is no Planet B

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