Sustainability in IT and Infrastructure design and operation:

Addressing environmental issues, energy/material/carbon footprint

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CCI Seminar, University of Amsterdam
Presented 10 September 2021

Outline

- Sustainability in UN SDG and European Strategy on Sustainability and Horizon Europe Mission Goals
- Sustainability definition and KPI
- Defining Architecture model for Data Driven Applications optimisation
- Discussion
  - Sustainability of the key IT technologies of our economy
  - Sustainability in our research and development
  - Sustainability in our digital habits

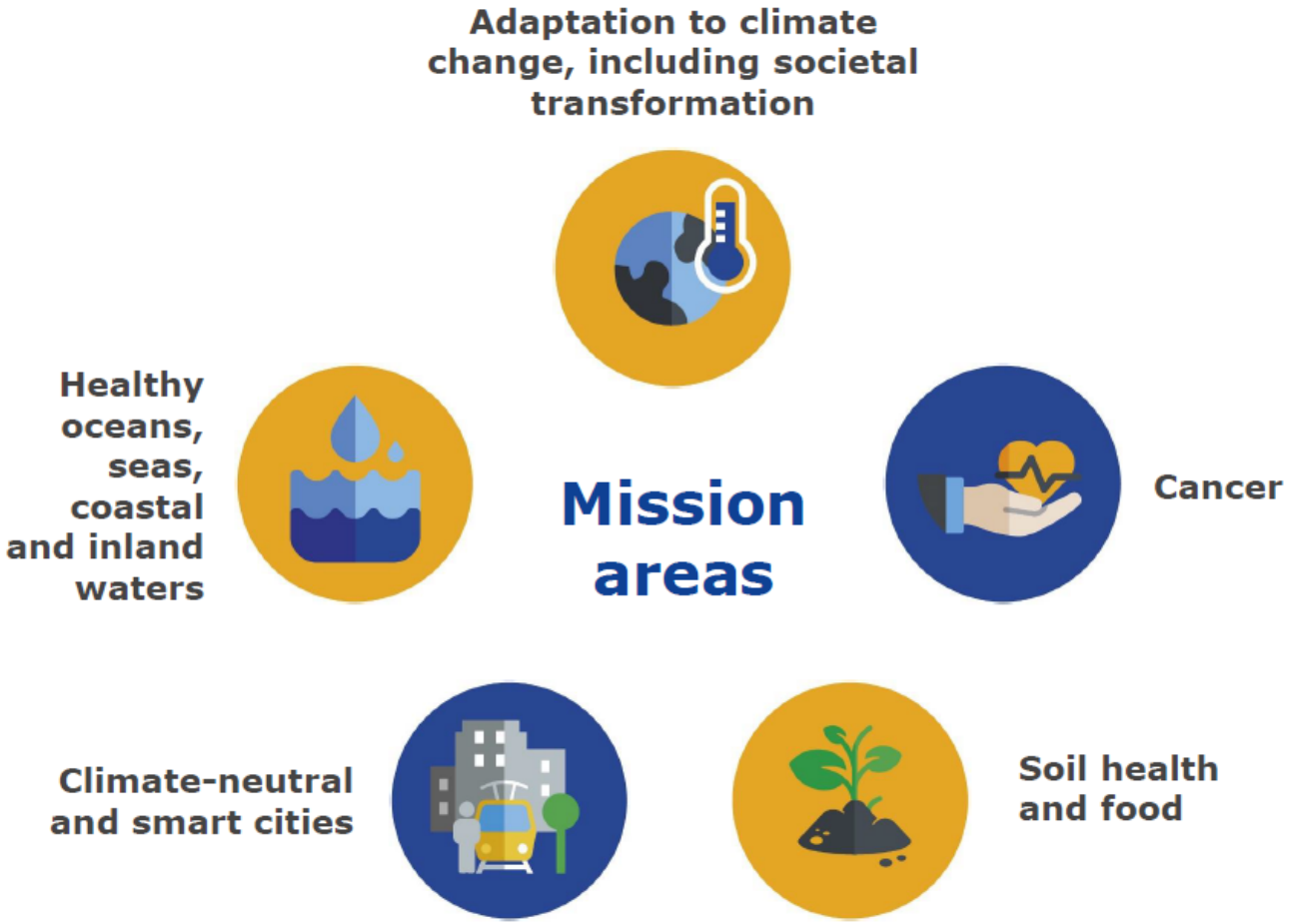
Horizon Europe Preparation and Concepts

- Mission-oriented research and innovation in the European Union
- Focus on UN 17 SDG discussed during preparation stage

5 Mission areas in HE

- Adaptation to climate change including societal transformation
- Cancer
- Climate-neutral and smart cities
- Healthy oceans, seas, coastal and inland waters
- Soil health and food

- Contributing to Sustainability
  - European policy on cloud computing
  - Industry 5.0
  - European Data Spaces



(1) HORIZON-CL4-2021-DATA-01-01: Technologies and solutions for **compliance, privacy preservation, green and responsible data operations** (RIA) – total 52Mln / 10Mln prj

- Activities are expected to start at TRL 2-3 and achieve TRL 4-5 by the end of the project

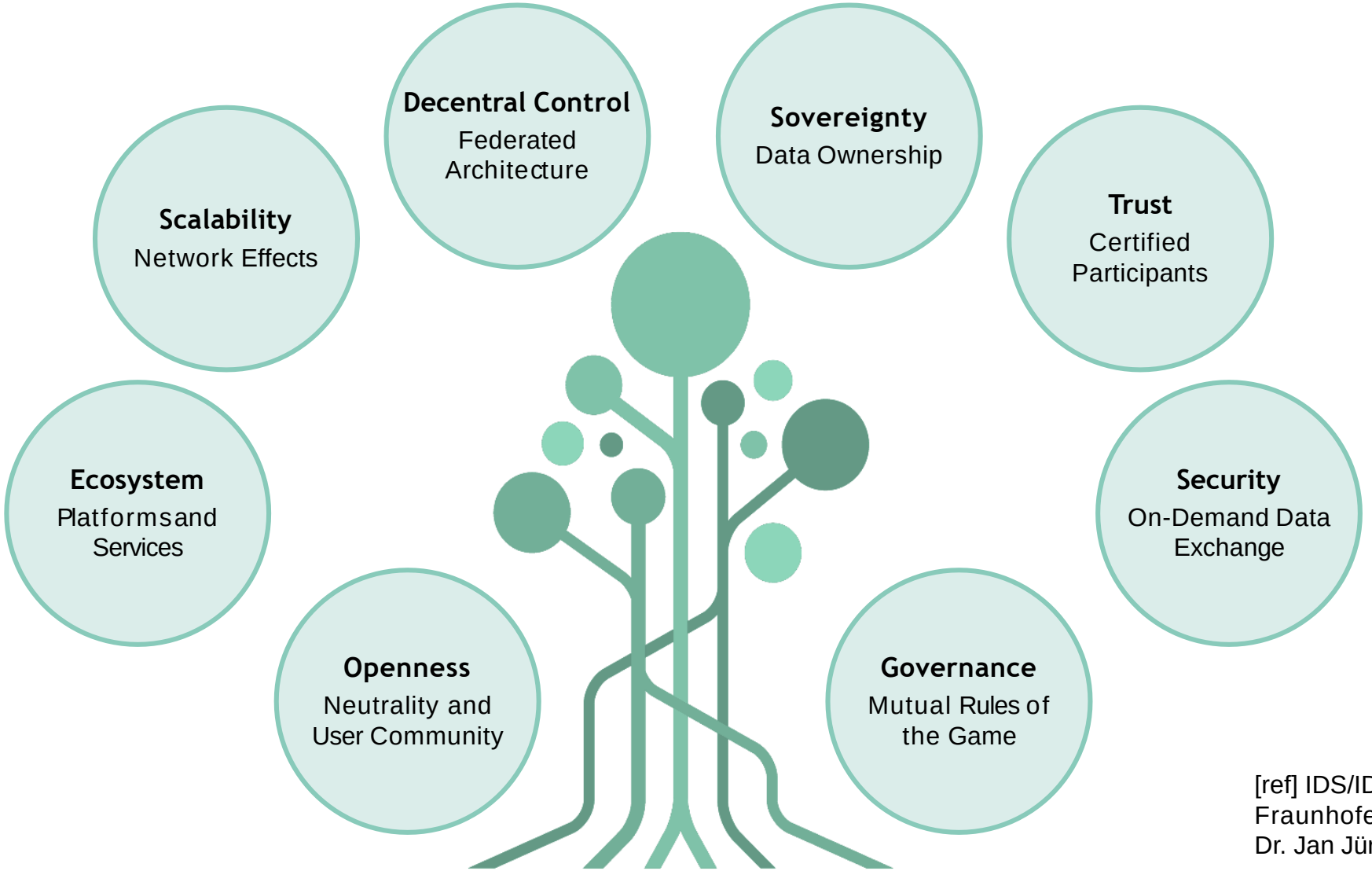
Expected Outcome: Project results are expected to contribute to the following expected outcomes:

- **improve the efficiency and the use of trustworthy digital technologies** to address the requirements of citizens, companies and administrations/public organisations on **privacy and commercial and administrative confidentiality** as well as responsible, fair and environmentally friendly (**e.g. in terms of energy/carbon/material footprint) data operations in data spaces, across the data life cycle**.

Scope: **Digital technologies, methods, architectures and processes for user-friendly, safe, trustworthy, compliant, fair, transparent, accountable and environmentally sustainable collection, storage, processing, querying, analytics and delivery of data**.

- The technologies shall **facilitate sharing and manipulation of data** in compliance with prevailing and emerging legislation (e.g. GDPR) for data processors and data subjects/rightholders and other stakeholders.
- The technologies and solutions shall **enable safe and secure data handling, sharing and re-use** in the context of common **European data spaces** in various situations and application areas.
- The scope also includes the combination of technological and social innovation, technologies and solutions that **enable environmentally sustainable data operations** (e.g. by **optimising/minimising/de-centralising processing, transfer and storage of data and avoiding unnecessary data manipulations, using energy-harvesting sensors/devices etc**.),
- Technologies and solutions for **ensuring human, fair and ethically sound collection, processing and manipulation of data**, in line with the principles of responsible/trustworthy AI.

Industrial Data Spaces: Sovereign Data – How sustainability can be addressed?



- Data sharing and Sovereignty are key to make value of data
- Data Sovereignty achieved by attaching policy and usage conditions to data
- Enabling regulated environment for data processing
  - Enclave computing in modern cloud technology

[ref] IDS/IDSA slides courtesy Prof. Dr.-Ing. Boris Otto, Fraunhofer ISST,Industrial Data Space Association, and Prof. Dr. Jan Jürjens Fraunhofer, ISST, University Koblenz-Landau

SDG Goals and relation to ICT

Selected SDG goals (data technologies linked)

- 9. Innovation and Infrastructure
- 11. Sustainable cities and communities
- 12. Responsible consumption
- 7. Renewable Energy

- 13. Climate actions?
- 16. Peace and justice?
- 17. Partnership for the goals

ICT as facilitating factor for SDG:

- SDG related initiatives in Data Science

Data related technologies

Discussion topic 1

- FAIR Data principles?
- GDPR?
- Data Spaces, GAIA-X and IDSA Architecture?
- Data sharing and data markets?
- Stock exchanges and Blockchain?
- Cloud – edge – mobile access - smartphones?

Industry and production

- Automation, Robotics, AI

Sustainability breakout and mapping

- Sustainability in HE (Mission areas) is considered in the context of SDG

- Societal impact
  - People and skills
- Energy efficiency as part of Environmental impact
  - Energy re-use
- Resources
  - Circular economy

Definition: Sustainable IT

https://circularcomputing.com/what-is-sustainable-it/

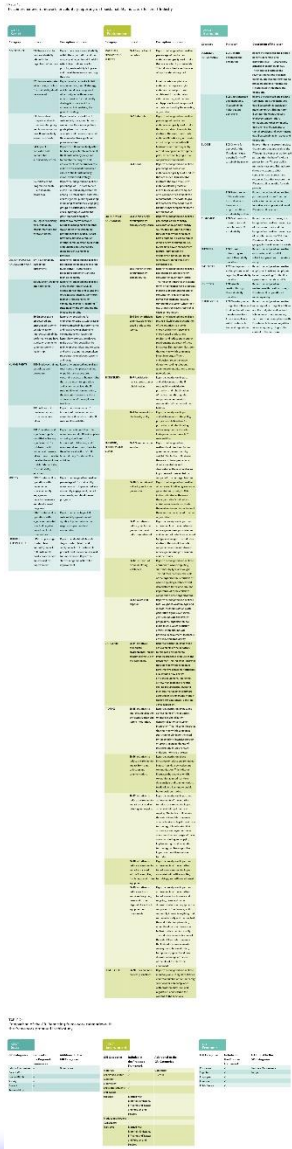
- Sustainable IT, also known as Green IT, covers the **manufacturing, use, management and disposal of information technology** in a way that minimises its impact on the environment.
  - Read about resources required for production one laptop
- The Green Software model includes
  - Software lifecycle, sustainability criteria, product metrics, procedures for stakeholders, stock recommendations, and tools that support environmentally friendly sustainable development, acquisition, supply, and use
- Sustainable capabilities in social axis
  - Practices, adding value to customers, stakeholders, and society to provide long-term benefits in economic, social, and environmental pillars

Sustainability Indicators: Key to Operationalise Sustainability

- Three main pillars of Sustainability:
  - **Economic, environmental, and social**.
- Sustainability indicator is **a measurable aspect of environmental, economic, or social systems** that is useful for monitoring changes in system characteristics relevant to the continuation of human and environmental well being
  - Sustainability indicators must cover economic, social, and sustainable aspects of human activities
  - Sustainability indicators should be politically relevant, resonant, scientifically valid and measurable, i.e. obtained information must be actionable.
- Global Standards for Sustainability Reporting – GRI, Global Sustainability Standards Board (GSSB)
  https://www.globalreporting.org/standards/

IT Sustainability Indicators for the IT Industry (10 July 2015) by

https://www.deitauditor.nl/business-en-it/it-sustainability-indicators-for-the-it-industry/
https://www.norea.nl/

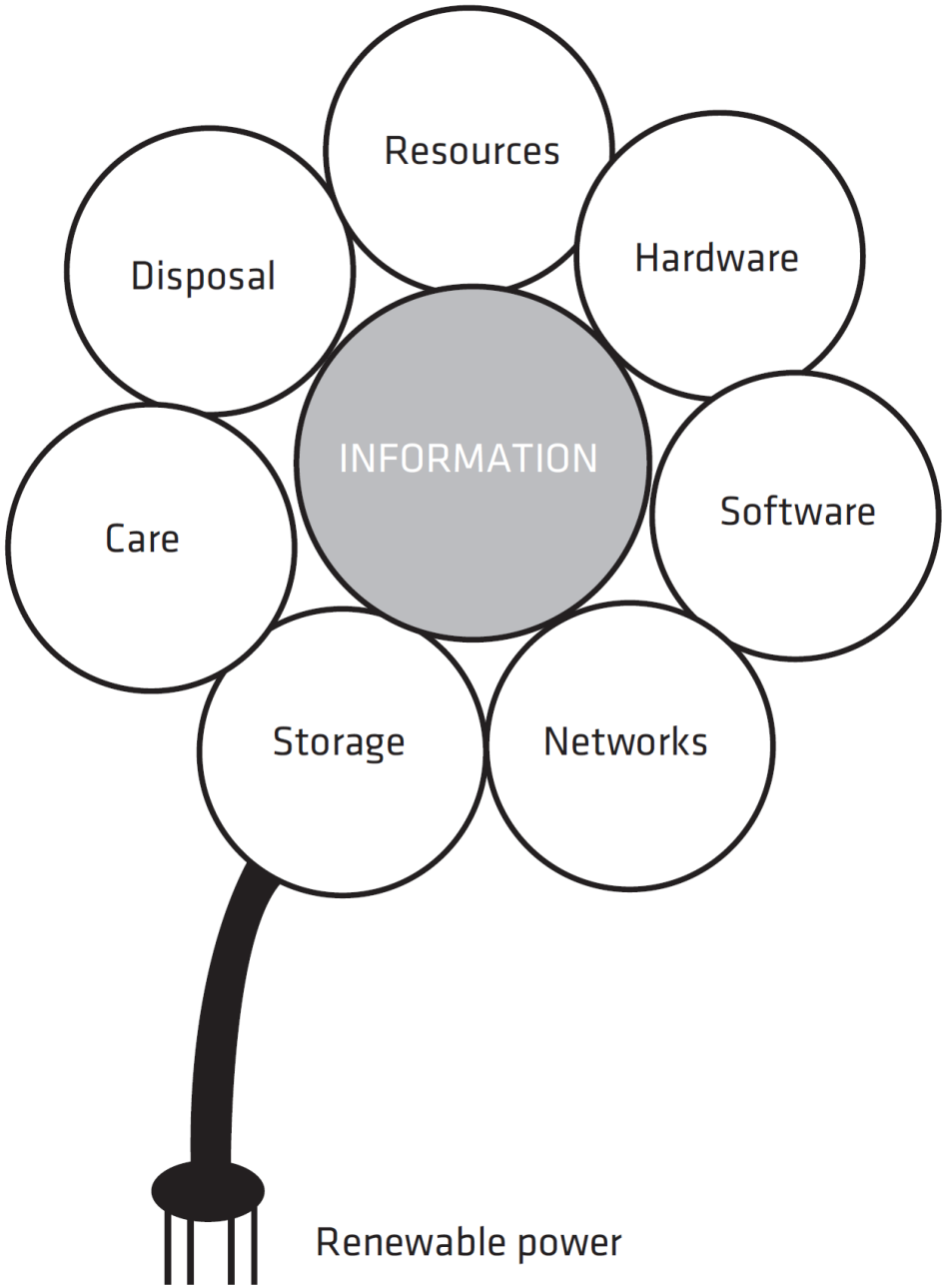


- The IT sustainability indicators are developed according to the criteria for financial statements that are set out in the International Accounting Standards Committee (IASC) framework: comprehensibility, relevance, reliability and comparability.
- The GRI Reporting framework was adopted as basis for the development of the proposed framework, because it is the world's most widely used sustainability reporting framework.
  - Most of the core GRI Reporting framework indicators are included in the proposed framework. However, for simplicity, the framework does not distinguish between core and additional indicators.
  - The GRI framework was extended with IT sustainability indicators.
- The proposed framework to help companies with their voluntary reporting on IT sustainability's social, environmental and economic aspects:
  - 3 aspects: Social, Economic, Environmental
  - 13 categories, including materials, products and services; energy, water and cooling; biodiversity; effluents and waste; data center; IT office; compliance
  - 44 indicators

Economic Sustainability KPI relevant to IT Operation

- GRI and IASC Framework: 13 categories defined
  - data center
  - IT office
  - compliance
  - products and services
  - Energy
  - water and cooling
  - Materials
  - effluents and waste
  - Biodiversity

The sustainable IT "flower"

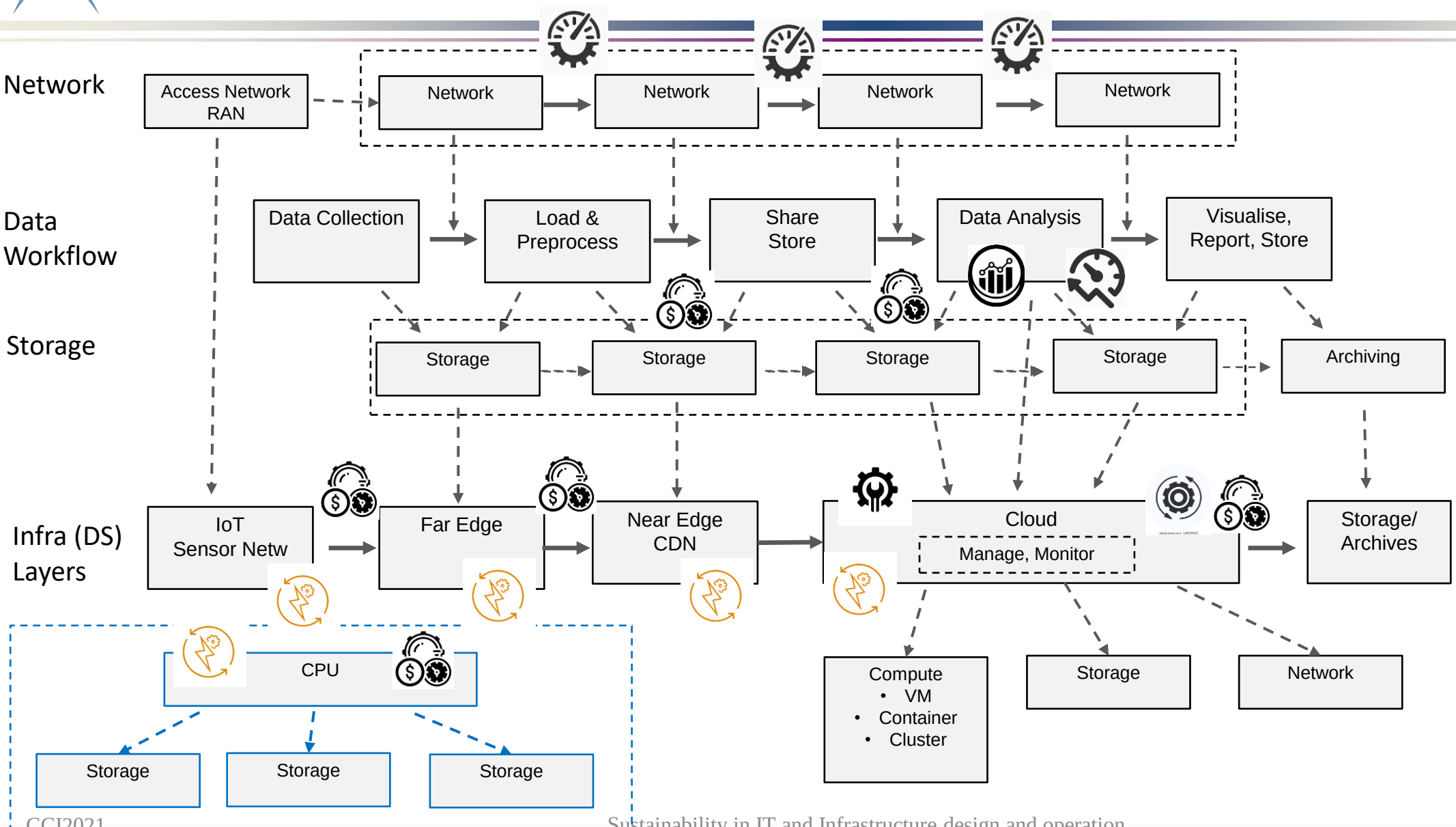


Sustainable IT components

https://www.apc.org/sites/default/files/PracticalGuideSustainableIT_Section_1.pdf

- Hardware
- Software
- Network
- Storage
- Care/Management
- Disposal
- Resources

Architecture Model for Data Driven Applications (DDA) Optimisation: KPI to be defined



Optimisation targets (not independent)

- Speed Opt
- Algorithm Opt
- Conf&Econom Opt
- Conf&Operat Opt
- Conf&Mngnt Opt
- Energy Opt
- Speed&Perf Opt

Problems identified: Sustainability modeling, Monitoring, Optimisation

- Revise existing definitions of Sustainability
- Define model for data lifecycle and whole infra stack
  - Exchange data between domains (data spaces – federated data spaces)
- Model definition and simulation – use Digital Twins
- Model to adopt technology change that solve many early optimis problems
- Are KPI defined?
- Measurement for KPI?
  - Digital Twin as a container for a model
  - Sensitive information
- Operationalising of analytic and AI models
  - DevOps and SRE (Site Reliability Engineering) practice for continuous monitoring and improvement (KPI and Service Level Objectives based)
  - What actions to take and how? Translate model output to action
- Review IoT community experience

From DevOps to SRE: Operationalising SE/Apps, Data Analytics/DataOps and MLOps

- Benefit from current trends to operationalize engineering/development process
- SRE (Site Reliability Engineering) introduces practice of monitoring and fulfilling Service Level Objectives (SLO, subset of SLA) by defining Service Level Indicators (SLI)
  - To be leveraged to Data Analytics model monitoring and improvement
- SRE may provide an approach to facilitate early DA model deployment and testing with real data

Re-think your digital habits: Our online Behavior

https://digital4planet.org/re-think-your-digital-habits-white-paper/

- Download rather than stream and drop quality if possible
- Reduce number of Google searchers
- Switch to more socially conscious and sustainable search engines.
- Every email uses energy: Each byte cost money
- Choose a green email provider
- Share documents and photos
- Turn off social media notifications
- Switch off and disconnect on regular basis

Sustainable search engines (not verified):

- Ecosia *(https://www.ecosia.org)*
- Lilo *(https://www.lilo.org)*
- Ecogine *(https://ecogine.org)*
- YouCare *(https://youcare.world)*
- GEXSI *(https://gexsi.com/en)*

Re-think your email habits

- Search and destroy
- Take out the trash
- Manage your subscription
- Avoid sending unnecessary emails and avoid sending emails to many people
- Think about unnecessary quotation in the response email

Re-think your digital habits: Poluting impact of our devices

https://digital4planet.org/re-think-your-digital-habits-white-paper/

- Use Dark Mode on your devices: Dark Mode can reduce the display power
  draw by up to 58.5%.
- Repair instead of replace and try using your devices longer - instead of changing them even if they still work fine.
- Choose “greener” devices whenever possible that typically:
- Recycle! Don't keep your old devices at home in your basement, as many materials can be recycled.
- Reduce your devices’ energy consumption.

Greener devices:

- Consume less energy
- Use recycled materials
- Can be repaired
- Limit the use of materials that can damage our health
- Check the label - there are a number of standards to certify the ecofriendliness of devices.

Reduce device energy consumption

- If not using your computer or your printer, switch them off, instead of putting them in sleep mode (controversial).
- Switch off your devices completely during the night - including TV boxes, wifi routers, laptops, mobile phones, etc.
- The average annual consumption of a TV box is equivalent to that of a refrigerator.
- Limit the number of open (and unused) applications and documents on your devices - this consumes lots of energy!
- Deactivate GPS, WIFI and Bluetooth options when not needed – they consume lots of battery!

Some data on laptop consumption (personal experimental observation)

- **Dell Inspiron 17 inch (advanced config Intel Core i9, SSD 1TB, RAM 32GB, Toch 3840x2400)**
- Normal consumption with charged battery and 55% screen brightness 16-18 W
  - Increase to 100% brightness + 6 W
  - When charging battery +80-90 W
- Large files transfer (local network)
  - WiFi 2.4 GHz up to 600 Mbps (real 55 MB/sec) +15-18 W
  - Ethernet 1Gpbs (real 105 MB/sec) +18-20 W
- Upload to OneDrive while synching 25-30 W
- Email (Thunderbird)
  - Copy email from IMAP server + 18-20 W
  - Sending big file (IMAP account) 8.6 GB + 12-15 W
  - Downloading POP email with 8,6 attachment + 18-22 W
- Adobe Acrobat (Loading large file and browsing) +20-30 W
- GoogleDrive access (via browser) + 30 W pick for 10-15 sec
  - File upload/sync + 12-15 W
- GoogleDoc
  - Open file +18-25 W for 5-8 sec
  - Committing changes in editor +20+ W
  - Refresh editor tab +20-50 W
- Microsoft Word/Office: Active editing + 5 W
- Playing movie from local file +5-7 W
  - Local VLC video +6-8 W
- Netfix movie +15-20 W

Discussion

- Topic 1: Sustainability of the key IT technologies of our economy
- Topic 2: Sustainability in our research and development, including research/development stages
- Topic 3: Sustainability in our digital habits

Discussion Topic 1: Data related technologies: How much they contribute to sustainability?

- FAIR Data principles?
- GDPR?
- Data Spaces and IDSA Architecture?
- GAIA-X?
- Data sharing and data markets?
- Cloud – edge – mobile access - smartphones?
- Stock exchanges and Blockchain? Ethereum 2.0?

Discussion topic 2: Sustainability in Research

- Reflect on your own research style and practice
  - Use of cloud resource vs local cluster for experimentation and big data processing
    - Using GPU vs general CPU
  - Creating own papers archive vs repetitive search and read online
  - Printing papers and multiple reading and marking up vs multiple reading electronically
  - Introducing sustainability criteria into your solutions, in particular programming

Discussion topic 3: Sustainability in Your Digital Habits

- Reflect on your own digital habits
  - Using online vs offline services (cloud drives, cloud office)
  - Email attachments vs sharing services
  - Email response quotation
  - Video streaming vs download
  - Video watching on laptop vs tablet vs phone