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GreenDIGIT

WP6 (T6.2) – Technology enablers for energy efficiency in Research Infrastructure

University of Thessaly (UTH)

WP6 T6.2 Modelling and optimisation of IoT resources

- **Task Duration / Timeline:** [M13-M36]
- **Correlated Milestones:** MS6.2 [M24] *“ Modelling and optimisation of IoT resources with documentation is ready for implementation.”* →
  - IoT optimization algorithms and their documentation are available for integration.

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WP6 T6.2 Modelling and optimisation of IoT resources

- **Scope / Goals:**
  - Enable intelligence in the RI lifecycle management.
  - Consider metrics from cloud-to-things continuum.
  - Develop monitoring solutions for IoT devices, to achieve a unified monitoring system across heterogeneous platforms.
  - Fed the metrics into a Multi-level ML model.
  - Create forecasting for the values received from different parts of the continuum.
  - Combining them to make conclusions on energy, performance and operational costs.

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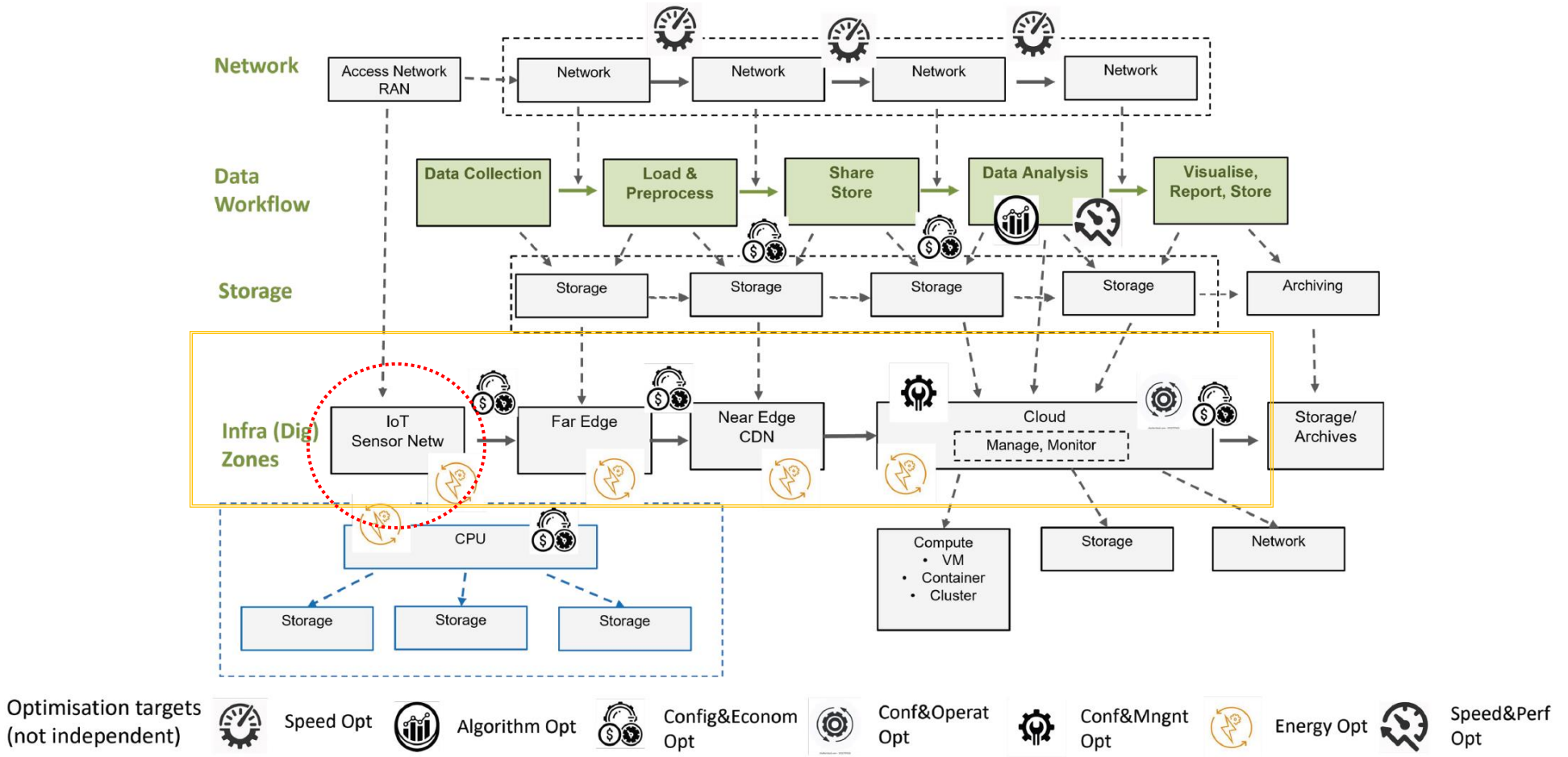
WP6 T6.2 Modelling and optimisation of IoT resources



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T6.2 Integrations / Correlated Tasks

- **Integration with T6.1:** Metrics collected from the framework should be compatible with the publication system defined in T6.1.
  - Open APIs: Use RESTful APIs (to be decided from T6.1) to exchange data with central DB.
- **Correlation with other WPs:** T6.2 acts as the implementation and operational layer for the insights, frameworks, and tools provided by WP4 and WP5:
  - Architecture aspects
  - Metrics and KPIs

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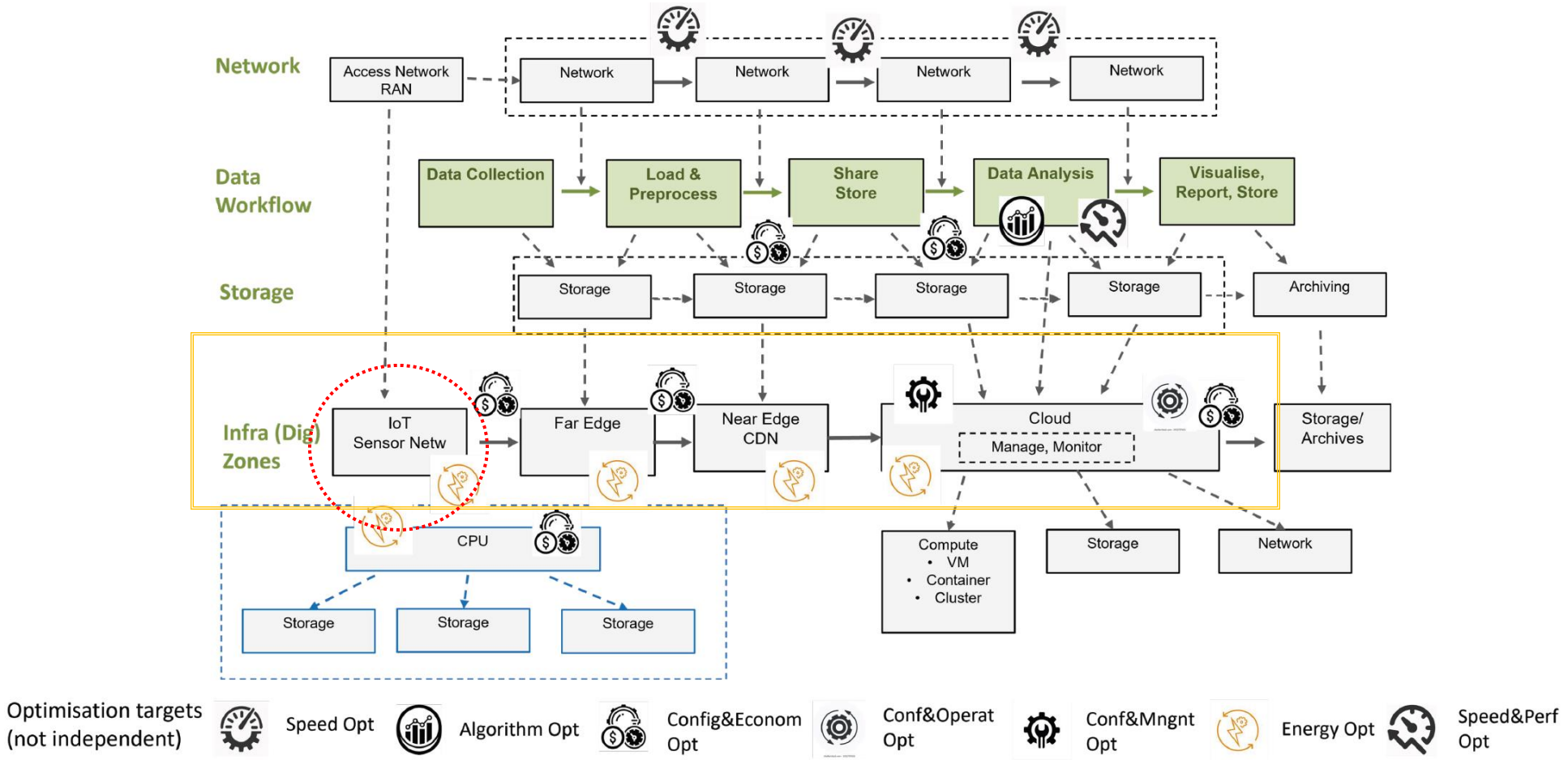

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T6.2 Entities characteristics

- **IoT Sensor Network, Far Edge, Near Edge and Cloud:** can be categorized through the following characteristics:
  - Proximity
  - Computing Power
  - Latency
  - Energy
  - Communication

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IoT Sensor Network Details

- **Definition:**
  - The layer composed of sensors and actuators that collect raw data from the physical environment (e.g., temperature, humidity, motion).
- **Characteristics:**
  - Proximity: Closest to the physical environment (end nodes of the network chain).
  - Computing Power: Minimal (basic operations like data collection and transmission).
  - Latency: Lowest latency but limited processing capability.
  - Energy: Battery-powered or energy-constrained devices.
  - Communication: Uses lightweight protocols.
- **Example Use Case:**
  Sensors measuring soil moisture in smart agriculture.

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Far Edge Details

- **Definition:**
  - The layer that aggregates data from IoT devices and performs preliminary processing or filtering. It is typically located near the data source but may include more resource-constrained devices than the near edge.
- **Characteristics:**
  - Proximity: Slightly farther from the IoT sensors but still close to the source.
  - Computing Power: Limited to moderate (e.g., gateway devices, industrial edge devices).
  - Latency: Moderate latency; processes data before sending it upstream.
  - Energy: Better energy resources than IoT sensors, often powered by mains.
  - Communication: Acts as a relay between IoT devices and the upper layers.
- **Example Use Case:**
  A companion computer / gateway aggregating sensor data, compressing it, and sending it to the near edge or cloud.

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T6.2 Validation and Feedback Goals

- **Deploy prototypes:** Real-world scenarios (e.g., small-scale IoT deployments).
- **Compare predictions:** Observe the predictions and compare them with the actual results.
- **Feedback loop:** Potential use of a feedback loop to refine the ML models and improve accuracy over time.

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Energy Measuring on IoT devices

- **Software Processing consumption:** IoT CPU / GPU workload impact, can be calculated and measured in node through software.
- **Software Communication consumption:** measuring. State (TX/RX/Sleep) oriented
  - Energy profiling software (some microcontrollers like STM32 provide information).
  - Firmware-Level logging.
- **Hardware consumption:**
  - Depends on each IoT adapter → Type of connection (USB, PCI etc).
  - Measure the total energy consumption of the node (plug-meters).

How to optimize IoT energy consumption?

- **Optimizations by RI design:**
  - Selection of energy efficient hardware / wireless IoT protocols.
  - Selection of non-interfering devices when they coexist.
- **RAN optimizations:**
  - May include optimizations on lower network layers (MAC, network, transport), to support increased throughput / reduced collisions.
- **Network topology optimizations:**
  - Orchestration for workload allocation, between edge devices, fog devices and cloud computing.
    - Consider user / application constrains (e.g. latency)