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Real-Time Telemetry for Carbon-Aware Networking: Measuring and Reducing Environmental Impact

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Growing Environmental Impact of Networking

- The Information and Communications Technology (ICT) sector, which includes data networks, currently consumes approximately 2-3% of the world's electricity.
- By 2030, this could grow to 8-21% if left unchecked due to rapid global internet expansion and increased device usage.
- Unlike data centers, which have seen improvements in efficiency, networks have lagged behind
  - complexities in measurement
- Data transmission has become a significant, yet often overlooked, source of carbon emissions.

Challenges in Measuring Network Power Consumption

- Quantifying and subsequently reducing the consumption of electricity is no easy task:
  - Many contributors (client device, infrastructure, communication links)
  - Lack of awareness of the problem
  - Lack of standards
  - Lack of tools for collecting data

- Current network monitoring tools collect traditional metrics (latency, throughput, and packet loss).
  - Related to performance or security, rather than power consumption and its link to carbon impact

- Much of the work on power consumption has focused on data centers, rather than end-to-end networked systems.

Carbon Intensity as a Key to Network Emissions

- Knowing the total electricity usage is not enough.
- The carbon-intensity of that electricity must be derived to determine the carbon footprint of network elements.
- Carbon intensity is defined as the amount of carbon by weight emitted per unit of energy consumed.
- The data that we do have suggests that networks are a dominant component in the carbon footprint of digital infrastructure.

Enabling Real-Time Carbon Efficiency in Networking

- To properly account for the carbon efficiency of networking, we argue for an end-to-end approach, specifically:
  - Devices should be able to report their real-time or near real-time electricity consumption.
  - Devices should be able to report the carbon-intensity or quality of consumed electricity.
  - Applications and services should react in (near) real-time to carbon-related information collected from the network.

Challenges in Network Telemetry for Carbon Reporting

- Network equipment manufacturers tend to report the maximum power consumption of a platform.
  - The difference between average and maximum may be large (or small).
  - This may not accurately represent the actual platform carbon emissions.

- The absence of hardware support within the platform does not mean that we need to wait for new devices to come to the market.
  - It is possible to leverage proxy data that will indicate usage.

- To make use of the real-time information, there is a need for an end-to-end reporting mechanism.
  - Similar to in-network telemetry used for end-to-end network performance

Challenges in Network Telemetry for Carbon Reporting

- Electricity consumption is not an indication of carbon emissions.
  - The carbon intensity of the energy source must be factored in.

- A distinction could be made between elements consuming electricity from renewable energy sources versus fossil fuel.

- The availability of carbon intensity data is not without its challenges:
  - While many regions globally are making carbon intensity data available publicly, coverage is incomplete.
  - The frequency of the data updates varies considerably across regions.
  - The measurement data must also be verifiable.

Challenges in Network Telemetry for Carbon Reporting

- Both the energy provider, and the network operator, would need to add new support.
- The energy provider should send electricity-quality information (periodically or through dedicated API).
- The network operator should process and propagate this information as part of in-network telemetry (INT) updates.

Conclusion

- Networking needs to be carbon-efficient, like any other part of digital infrastructure.
- To achieve real progress, standard metrics need to be supported and reported by network devices.
- We call on the IETF community to join the effort to define these metrics. Together, we can make networking truly green.