IAB Workshop on Environmental Impact of Internet Applications and Systems
Session 3: Potential Improvements
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Metrics

https://datatracker.ietf.org/doc/html/draft-cx-green-metrics-00

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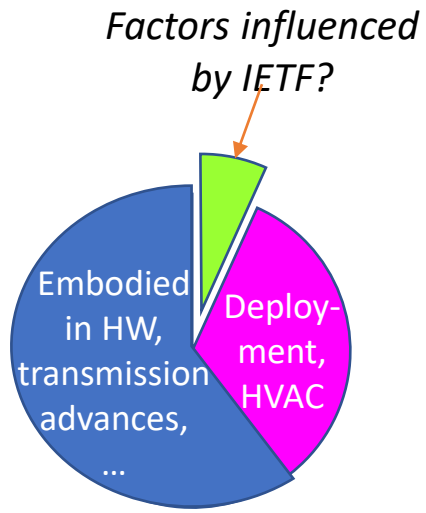
Context

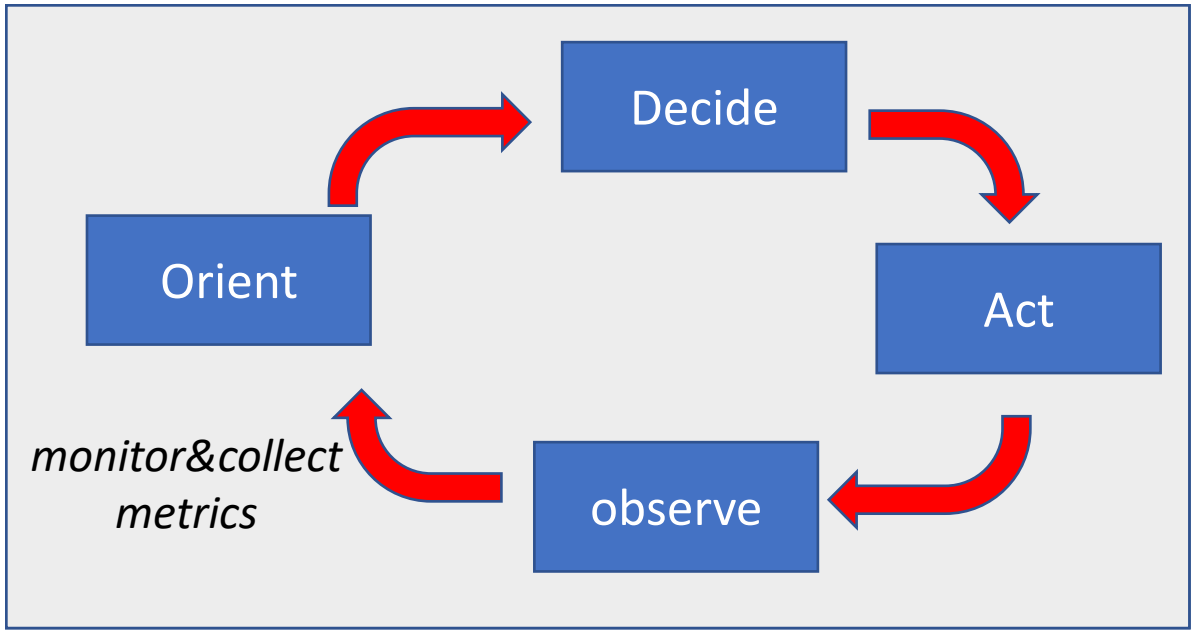
- Reducing carbon footprint to “Net Zero” is one of mankind’s “Grand Challenges”
- Networks are a key enabler for solutions but also a problem contributor
  - Networks consume lots of energy themselves
  - Net Zero mandates will apply to network providers as well
- Key contributors to network energy efficiency today
  - General hardware advances (e.g. Moore’s law – but slowing)
  - Deployment factors (e.g. Nordic locations for datacenters)
  - Antenna technology, transmission (e.g. physical layer stuff)
  - Shift towards sustainable power sources (where available)
- What about network- and management-specific factors?
  - What are ways in which the IETF can contribute?
  - Even if just a smaller slice of the pie, everything counts…



Things where networking can contribute

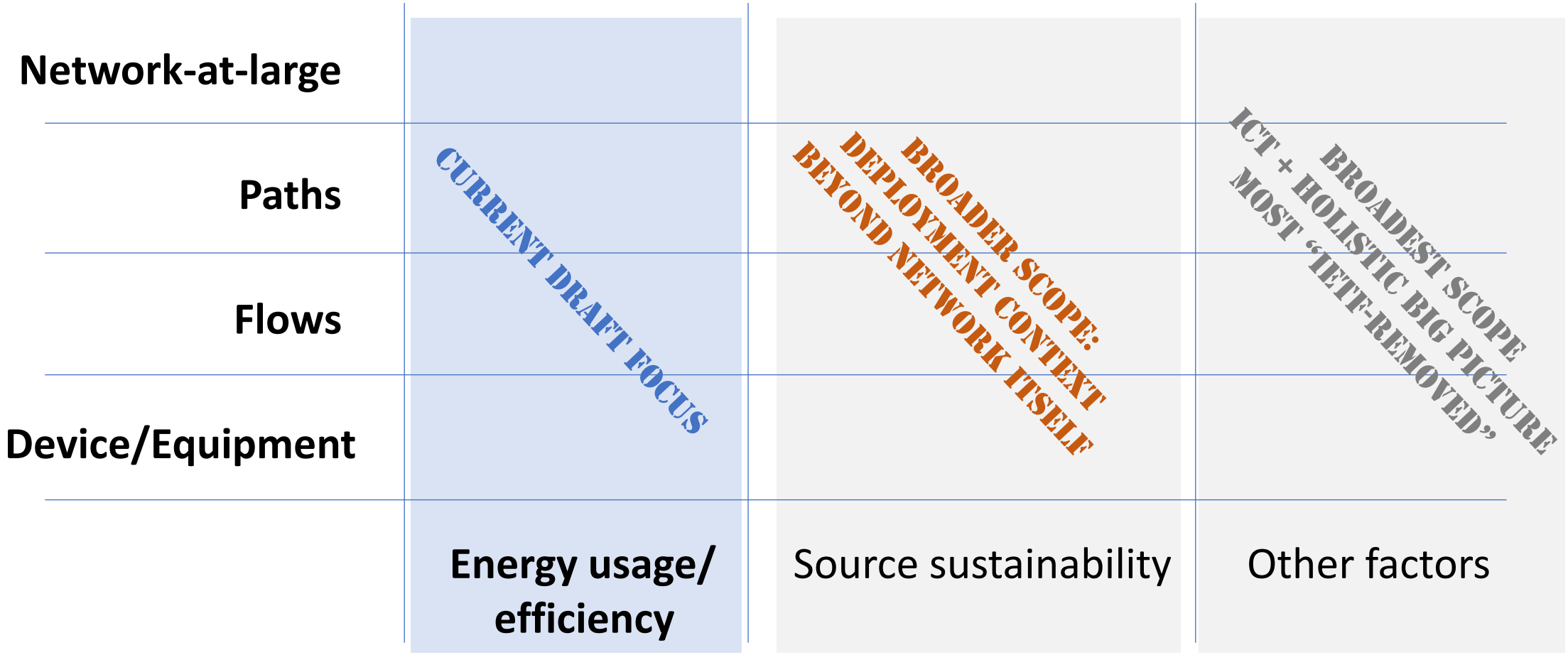
- Management, deployment, network optimization
  - Provisioning, dimensioning, managing oversubscription, …
  - Energy usage is a great parameter to optimize, just like utilization, cost, etc
  - VM+VNF placement, planning of routes/segments/paths
  - Moderating tradeoffs: carbon intensity versus service levels, utilization versus service levels, caching versus access, etc
- Control
  - Selecting from greener path alternatives, carbon intensity as a cost
- Network architecture (e.g. where to cache from carbon standpoint)
- Protocol design (chattiness, traffic smoothing vs bursting, etc)
- **It starts with visibility**
  - "If you can't measure it, you can't manage it" (Peter Drucker)
  - … or assess effectiveness of solutions, or devise solutions relying on control loops…
- And **visibility starts with the right metrics** – foundation for everything else
  - Actionable and where IETF may be able to make an impact

Metrics



- What metrics are needed
  - To assess effectiveness of a solution?
  - To compare alternative designs?
  - To optimize network deployments?
  - To make better control decisions?
  - To make better management decisions?
- What should metrics cover
  - Energy usage efficiency (scope: network itself)
  - Energy sources (scope: network++)
  - Other aspects: HVAC, manufacturing lifecycle, …
- How can a holistic picture be provided
  - Account for the whole picture, not just a part
  - E.g. device energy usage vs device lifecycle vs deployment environment energy usage
  - Tradeoffs – e.g. edge vs core, storage/memory vs bandwidth

Structuring the metrics space



***Disclaimers for what follows**:*

Not a comprehensive list of metrics, some may be speculative,
some may be less straightforward to instrument than others, usefulness may hinge on particular use cases

Device / equipment level

- Energy consumption metrics
  - Device ratings – data sheet stuff*
    - Power consumption when idle, at various loads (e.g. 50% utilization, 90% utilization)
    - For subcomponents: chassis, line cards, ports
    - For defined configurations: e.g. memory
  - Current energy usage
    - Current power consumption
    - Power drawn since system start, for the past minute, …
  - Derived metrics in relation to efficiency
    - Current power consumption per kilooctet
    - Incremental power consumption per kilooctet
- Source sustainability
  - Power source sustainability ratings* (per energy provider, operator mix of energy sources)
- Other considerations
  - Device sustainability ratings* (eco-friendly materials, easy recycling, embodied carbon intensity, sustainable production…)
  - Replacement lifecycle consideration* – metrics to indicate amortization of energy debt across eqpt lifetime
  - Deployment context (e.g. contribution to carbon footprint of hosting environment)
  - Discounted energy consumption metrics (weighed according to other sustainability factors)
  - Virtualization (attribution of power to soft switches, VNFs, slices vs just hosting hardware – ffs)

**Note: some of these metrics (e.g. sustainability ratings, data sheet items) may be provisioned and retrieved/discoverable on request, not variable/monitored in real time, but still useful for optimization purposes*

Beyond equipment

- Related to flows
  - Amortized energy consumed over flow duration
  - Incremental energy consumed over duration of the flow (0 with step function?)
  - …as observed on a device (see IPFIX), across the packet's path (note: account also for replication&drops)
- Related to paths
  - Path energy/sustainability rating (as a function of hop ratings)
  - Power consumption across a path (normalized, e.g. per kilooctet)
- Related to network as whole
  - Total energy consumption (MWh), network energy efficiency (MWh/PB)
  - Aggregates by which network providers are "measured", to be optimized

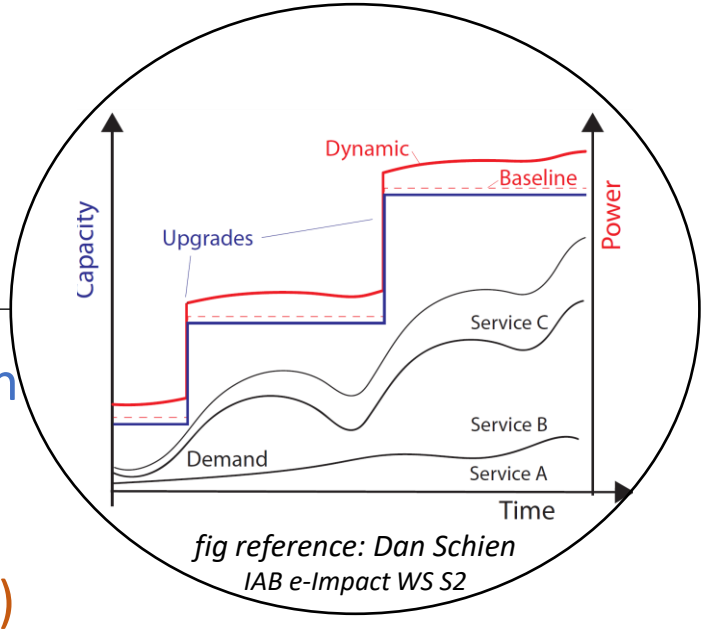


fig reference: Dan Schien
IAB e-Impact WS S2

Other considerations

- Instrumentation
  - Energy consumption versus carbon emissions
  - Beyond devices: obtaining metrics across paths, for flows (inband or otherwise)
- Certification and compliance
  - Inaccurate instrumentation may be counterproductive
  - Particularly important where regulation & monetary incentives get involved
- User perspective
  - Consider treating this not just as an operator problem
  - Attribute energy usage to usage & confront users with choices
- Next steps
  - This is quite actionable in IETF!
  - YANG models etc
  - Protocol extensions etc
  - Definition of solutions / use cases to drive those
  - …and advance the draft, of course (opsawg as landing spot?)
  - See also recipe@ietf.org mailing list

THANK YOU!