

NMRG@IETF114, Philadelphia, PA

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Management for Green / Sustainable Networking

Challenges and Opportunities in Green Networking

<https://datatracker.ietf.org/doc/html/draft-cx-green-ps-00>

Alex Clemm, Cedric Westphal, Jeff Tantsura, Laurent Ciavaglia, Marie-Paule Odini

Green Networking Metrics

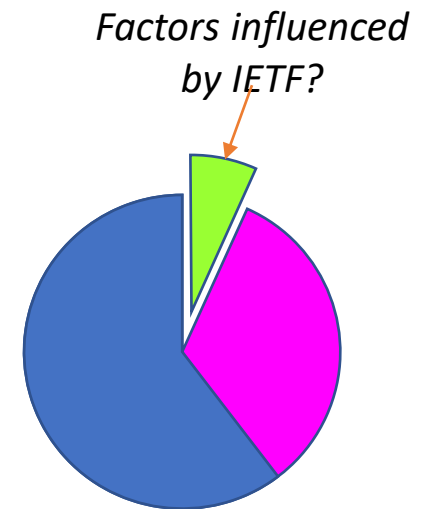
<https://datatracker.ietf.org/doc/html/draft-cx-green-metrics-00>

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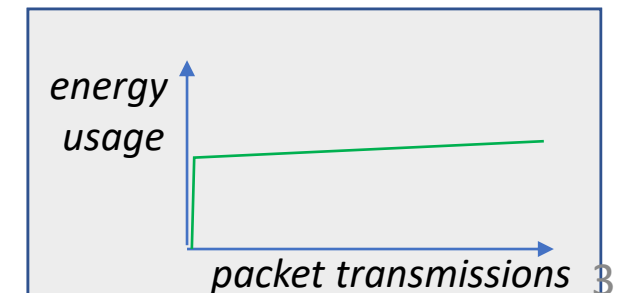
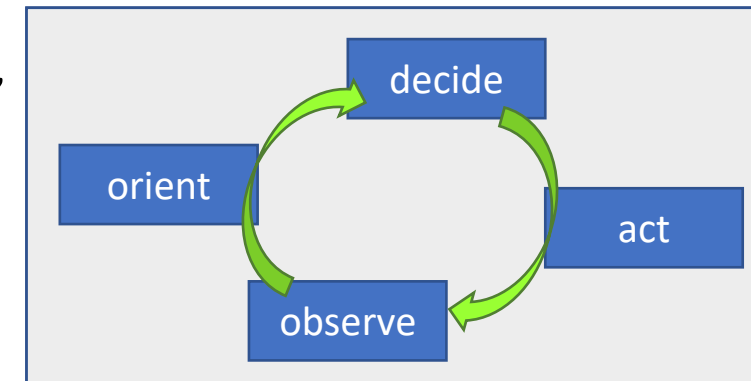
Why Green Networking?

- Reducing carbon footprint to “Net Zero” is one of mankind’s “grand challenges”
- Networking applications are a key enabler in this, but is this enough?
 - Substantial footprint enabler for a lot of “green” already
 - But, 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
- What about network- and management-specific factors?
 - What are ways in which the IETF can contribute?
 - Even if just a small slice of the pie, everything counts...



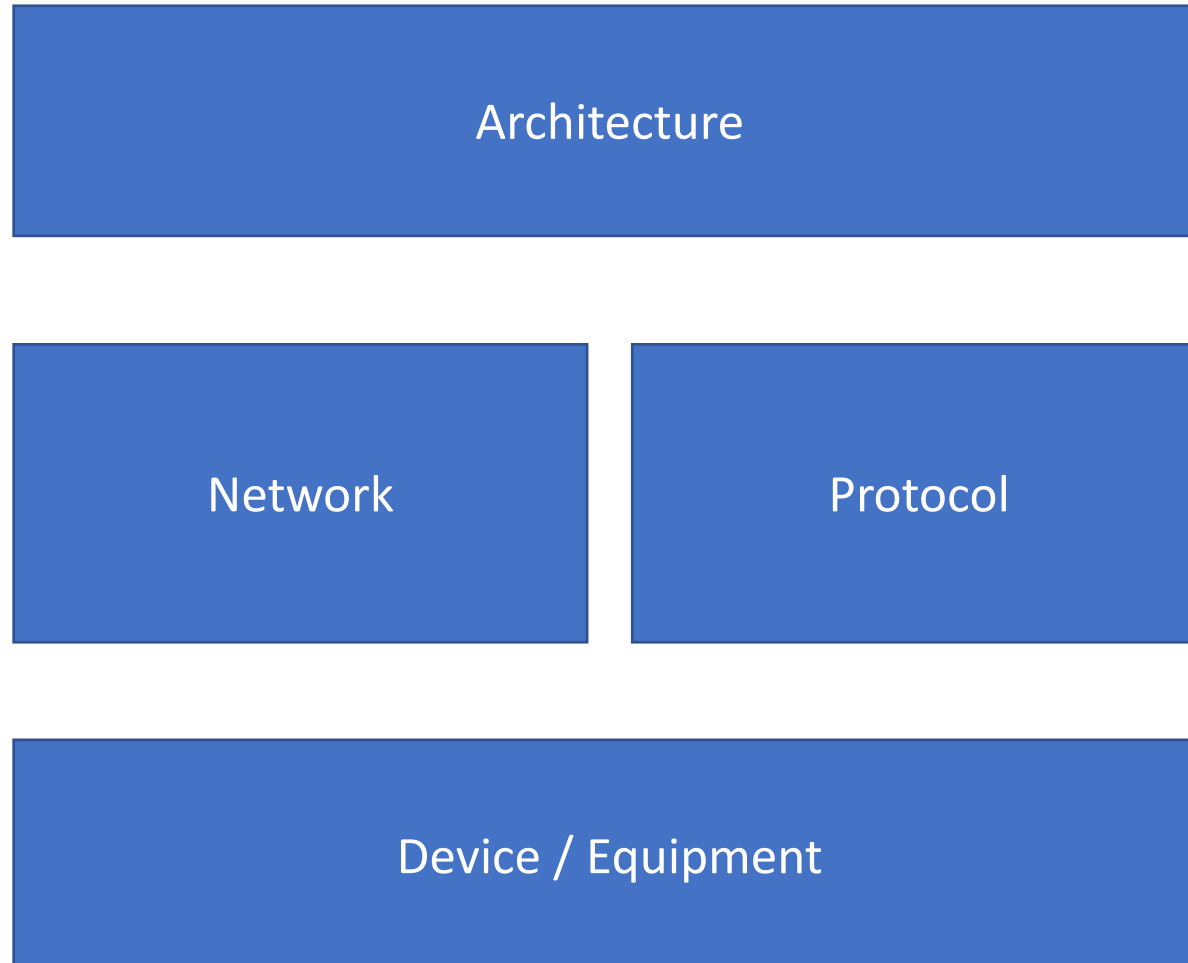
Some observations

- Management often involves deployment optimization
 - VM+VNF placement
 - Planning of routes, segments, paths
 - Moderating tradeoffs: resource consumption versus service levels, utilization versus service levels, caching versus access, etc
 - Energy usage is yet another parameter to optimize
- Management involves control loops
 - Visibility as the common enabler (so start here)
 - Very short time scales may be required as data transmission fluctuates wildly
- Communications characterized by non-linear incremental energy use
 - Cost of first bit is very high vs subsequent ones
 - Implies large potential gains by idling resources and taking offline (but: how to ready when needed?)
 - One thrust is to manage towards that



Structuring the opportunity space

draft-cx-green-ps (Alex Clemm, Cedric Westphal, Jeff Tantsura, Laurent Ciavaglia, Marie-Paule Odini)



Device / equipment level

- Important but mostly outside IETF scope
 - Power-efficient hardware, less heat dissipation
 - Eco-friendly materials, easy recycling at end of life cycle
 - Reduce energy usage of transmission technology (lasers, antennas)
- Getting closer
 - Control knobs to configure energy-saving policies
(power saving modes common in endpoints, what about equipment)
- Of specific interest here: provide visibility into current energy usage
 - Assess usage and validate effectiveness
 - Enable control loops for energy optimization schemes
 - Requires instrumentation for energy metrics

Protocol level

- Enabling network energy saving mechanisms
 - Taking resources offline often not practical due to time scales
 - What if those time scales could be dramatically shortened?
 - Requires mechanisms for fast discovery, fast state reconvergence
 - Role of autonomies? of IBN?
- Network addressing and deployment (e.g. smaller tables to maintain)
- Other aspects (with fewer management implications)
 - Traffic adaptation (e.g. bursty vs smoothened transmission to maximize efficiency)
 - Data volume reduction (e.g. codings, efficient retransmissions)

Network and network architecture level

- Network level
 - Energy-related control protocol extensions
 - Energy as a cost factor – in IGP, SDN controllers
 - Energy-aware routing & path configuration
 - Assess carbon intensity of paths, optimize networks to minimize overall footprint
 - Apply path-aware networking and segment routing to steer traffic along greener paths
 - Resource weaning schemes
 - Turning resources on/off while mitigating other operational goals (such as resilience); mitigate conflicting goals and coexist with other mechanisms
 - Deployment / placement of VNFs
 - Green abstractions, taking into account memory, processing, and transmission
- Architecture level
 - Facilitate organization of application to minimize energy consumption
 - Examples: retrieval of content, placement of computation (compare CDN/ICN/COIN but from energy perspective)

Network energy metrics

draft-cx-green-metrics (Alex Clemm, Lijun Dong, Greg Mirsky, Laurent Ciavaglia, Jeff Tantsura, Marie-Paule Odini)

- Enabler for “green” management: visibility
 - Peter Drucker: “You cannot manage what you cannot measure” (or observe)
 - This requires instrumentation, which requires metrics
- Related to equipment
 - Power consumption when idle, at various loads, current, since start, absolute vs normalized, etc
 - Think “YANG modules” (not part of the draft)
- Related to flows
 - Incremental/amortized energy over flow duration, at a device, across the flow, etc
- Related to paths
 - Path energy ratings, etc
- Related to network-at-large
 - Total energy consumption (MWh), network energy efficiency (MWh/PB)
 - Aggregates by which network providers are “measured”, to be optimized

Next steps

- Raise awareness & gain critical mass as a topic
- Two drafts on this topic have been posted as a starting point
 - Problem statement (Challenges and Opportunities)
 - Metrics (as a first specific work item)
 - Actually, three: draft-eckert-ietf-and-energy-overview
 - **Much** more (including more drafts) will be needed
- Looking for collaborators (and landing spot)
 - Challenges/opportunities a natural candidate for IRTF → NMRG
 - Metrics → opsawg(?), other topics TBD
- Comments? Questions? Please contact us
 - draft-cx-green-ps@ietf.org
 - draft-cx-green-metrics@ietf.org

THANK YOU!