

NMRG@IETF115, London, UK

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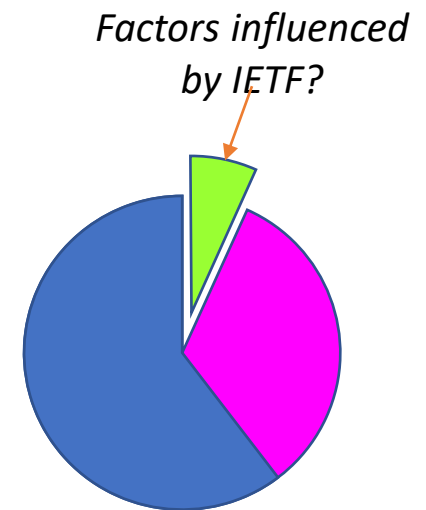
# Challenges and Opportunities in Green Networking

<https://datatracker.ietf.org/doc/html/draft-cx-green-ps-01>

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

# Why Green Networking?

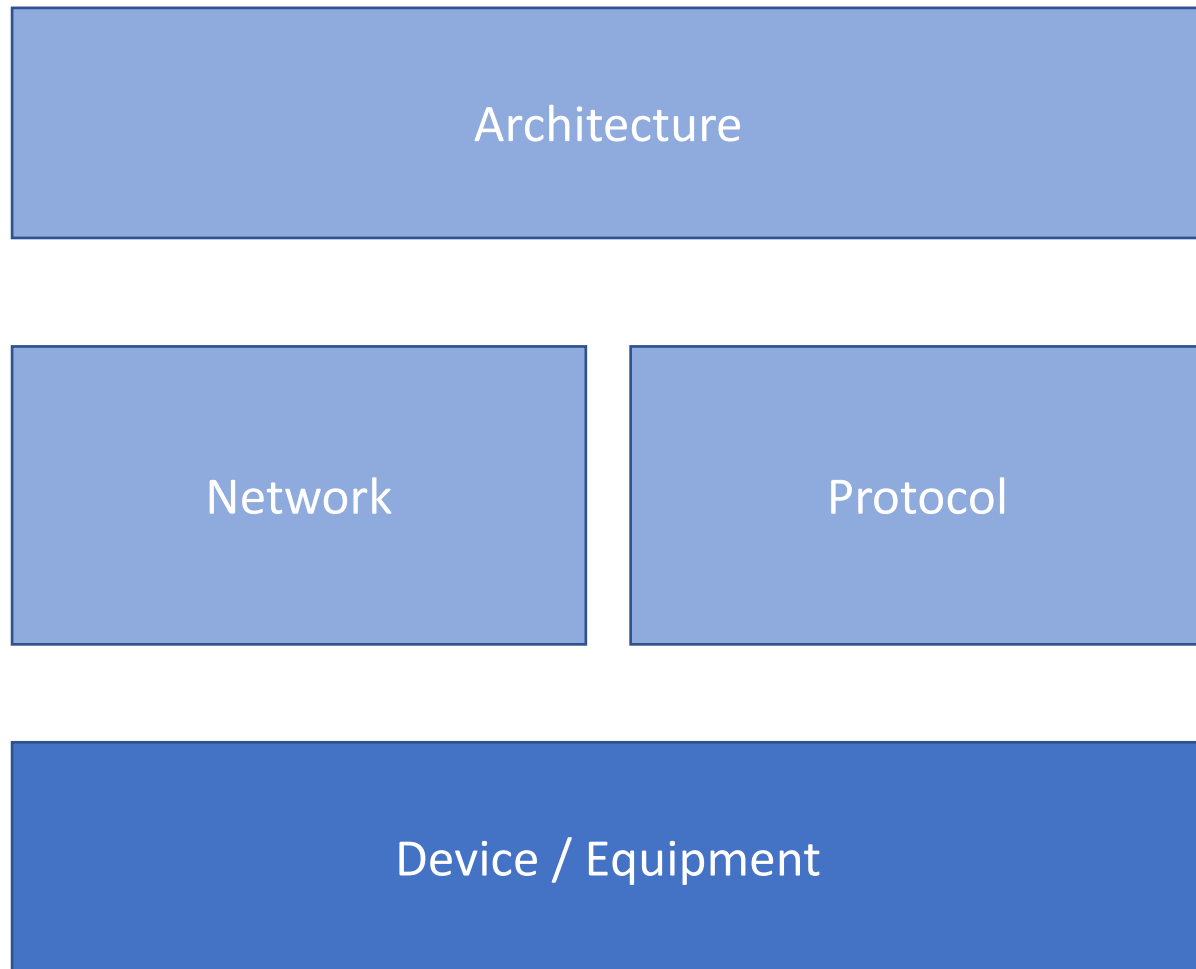
- Reducing carbon footprint to “Net Zero” is one of mankind’s “grand challenges”
- Networking applications are a key enabler in this, but is this enough?
  - Substantial footprint enabler for a lot of “green” already
  - But, networks consume lots of energy themselves
  - Net Zero mandates will apply 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 I\*TF can contribute?
  - Even if just a small slice of the pie, everything counts...



# draft-cx-green-ps-01

- Purpose: Analyze challenges and opportunities in green (sustainable, energy-efficient, carbon-neutral networking)
- We presented -00 of this draft in IETF 114
- Updates:
  - Editorial refinements throughout
  - Added emphasis to aspects beyond energy efficiency, e.g.
    - Energy sources and deployment aspects
    - Considerations for manufacturing lifecycle
  - Section 5.2 “Traffic Adaptation” changed to “Protocol Optimization”
  - Added possibility of covert channels to security consideration
  - New contributor (Michael Welzl, U of Oslo / Norway)

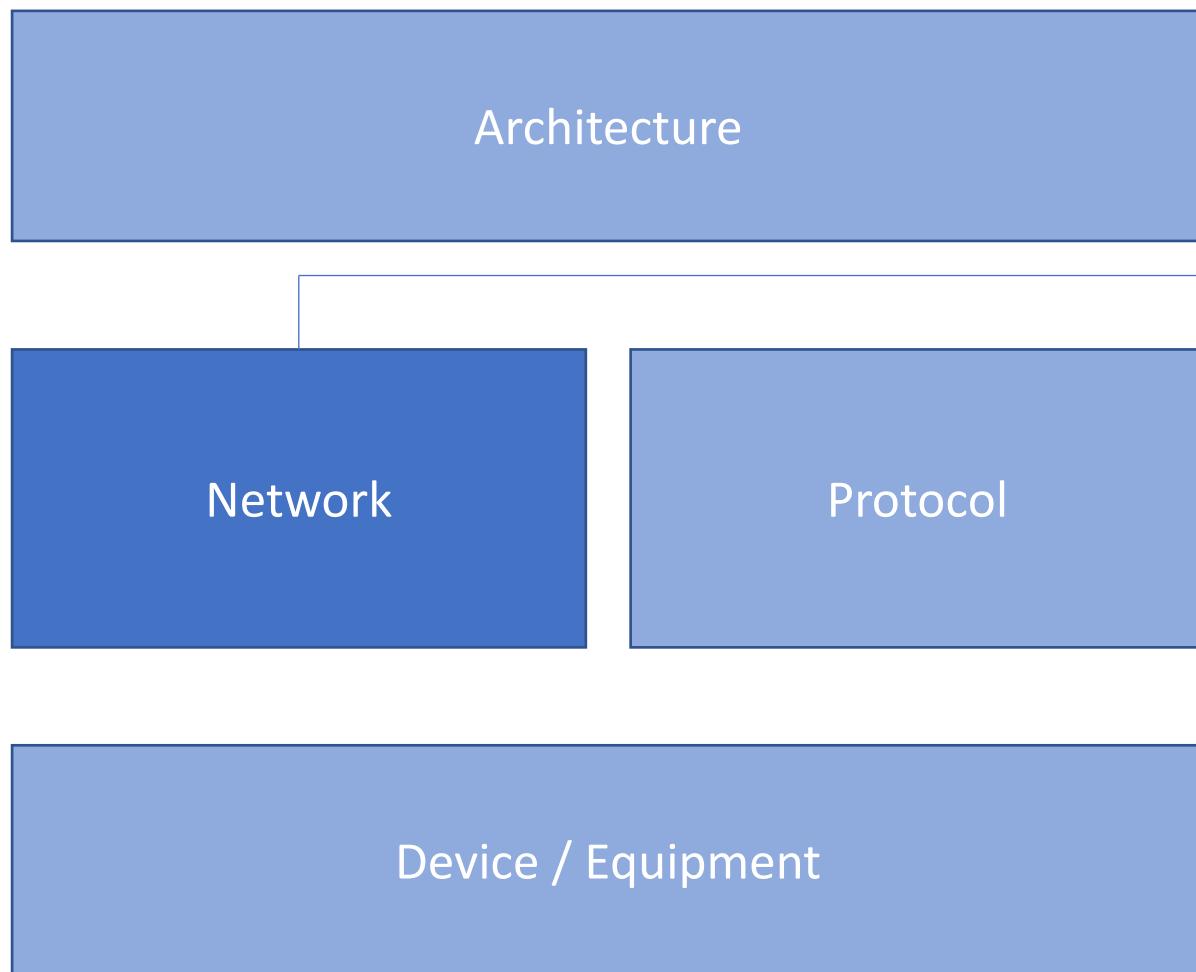
# Recap – structuring the opportunity space



Provide visibility as foundational problem:

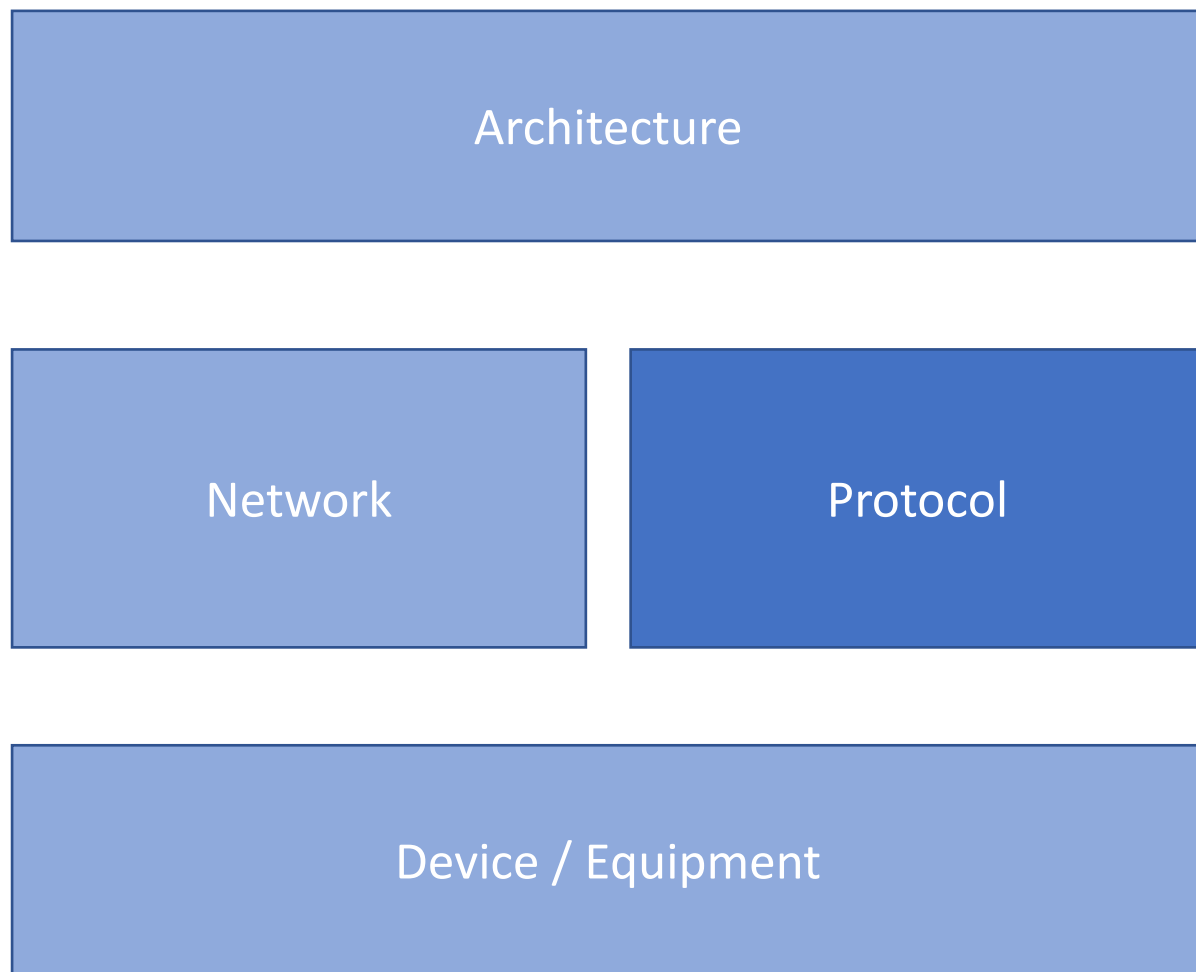
- **Assess usage, validate effectiveness**
- **Enable control loops** for energy/sustainability optimization schemes
- Requires **Instrumentation for energy metrics**
- Companion draft: Green Networking Metrics (draft-cx-green-metrics; <https://datatracker.ietf.org/doc/html/draft-cx-green-ps-01>)
  - Related to equipment:
    - Power consumption at various loads, absolute vs normalized, etc
    - Think “YANG modules” (not included)
  - Related to flows
    - Incremental/amortized energy etc
  - Related to paths
    - Path energy and sustainability ratings, etc

# Recap – structuring the opportunity space



- **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
- **Path-aware networking**  
to steer traffic along greener paths
- **Resource weaning schemes**
  - Turning resources on/off while mitigating other operational goals (such as resilience) and coexisting with other mechanisms
  - Deployment / placement of VNFs
- **Green abstractions**  
taking into account memory, processing, transmission

# Recap – structuring the opportunity space



- **Enabling network energy saving mechanisms**
  - Blur mgmt. and control – taking resources on/offline on short time scales requires mechanisms for fast discovery, fast state reconvergence
  - Role of autonomies? of IBN?
- **Network addressing and deployment** (e.g. smaller tables to maintain)
- **Instrumentation** (again)  
e.g. energy telemetry at flow & path level
- **Other aspects** (with fewer management implications)
  - Traffic adaptation (e.g. bursty vs smoothed transmission to maximize efficiency)
  - Data volume reduction (e.g. codings, efficient retransmissions)

# Recap – structuring the opportunity space

Architecture

- **Facilitate organization of networking applications** to minimize energy consumption
- **Examples:** retrieval of content, computation placement (compare CDN/ICN/COIN but from energy perspective)

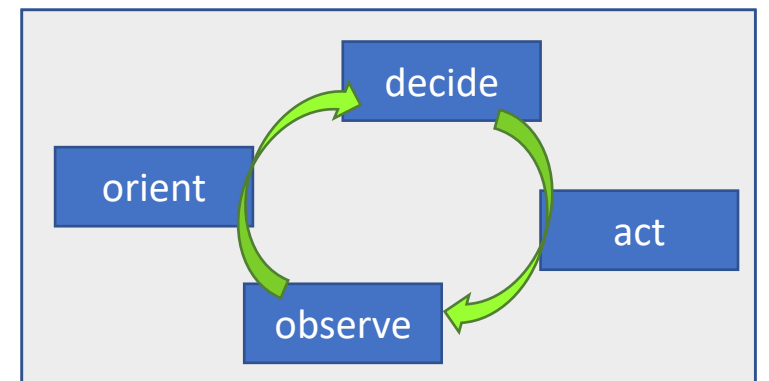
Network

Protocol

Device / Equipment

# NMRG as landing spot?

- Many (most?) of the challenges / opportunities are management-related
  - Visibility and instrumentation as common enabler (starting point)
  - Many opportunities involve deployment optimization...
    - Planning of routes, segments, paths
    - VM+VNF placement
    - Moderating tradeoffs: resource consumption versus service levels, utilization versus service levels, caching versus access, etc
    - Energy usage is yet another parameter to optimize
  - ... and management control loops
- Still involve research (that can lead to identification of standardization opportunities)
  - Makes IRTF/NMRG an excellent candidate





# Questions to NMRG

- Is management for sustainability a topic that NMRG is interested in taking on?
- If so, should we pursue / adopt draft as is?
  - Alternative: break out management specifics from a separate “umbrella” draft
- Comments? Questions? Please contact us  
[draft-cx-green-ps@ietf.org](mailto:draft-cx-green-ps@ietf.org)

**THANK YOU!**