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Challenges and Opportunities in Green Networking

https://datatracker.ietf.org/doc/html/draft-irtf-nmrg-green-ps-00

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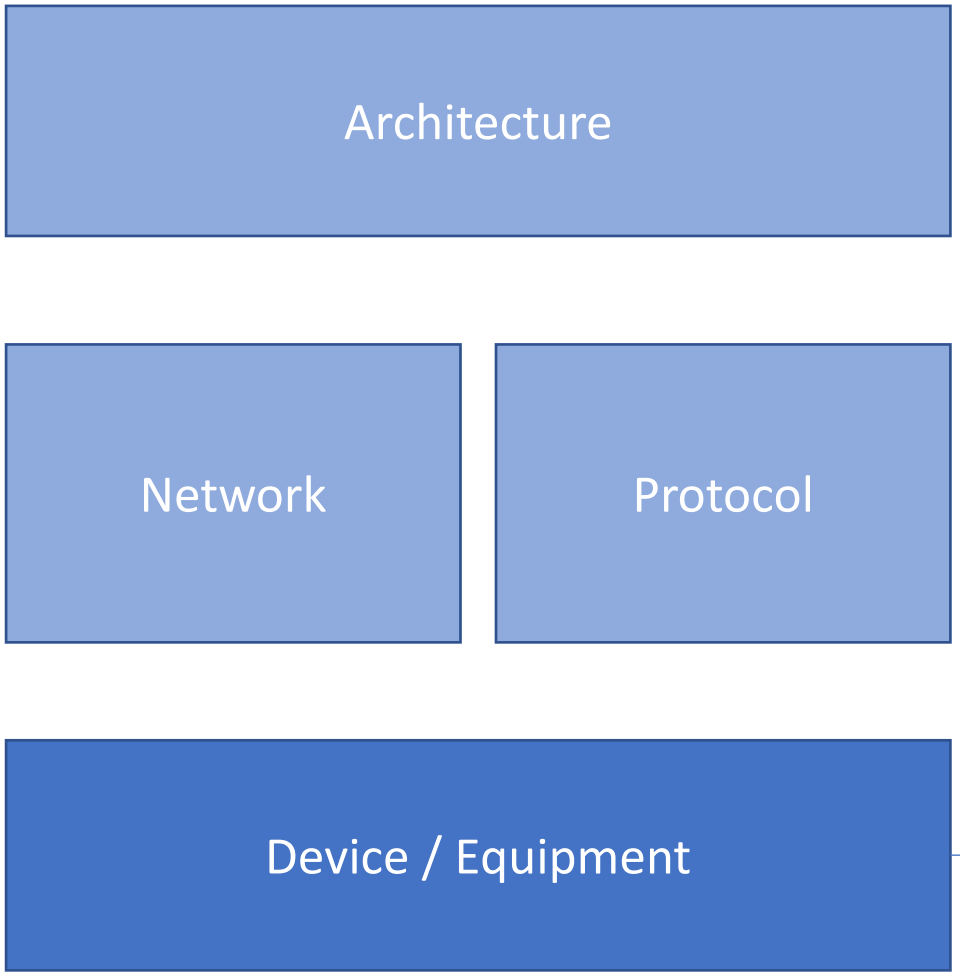
draft-irtf-nmrg-green-ps-00

- Purpose: Analyze challenges and opportunities in green (sustainable, energy-efficient, carbon-neutral) networking
  - Reducing carbon footprint to “Net Zero” is one of mankind’s “grand challenges”
  - This challenge also extends to network technology
- Adopted after IETF 116 – Thank You!

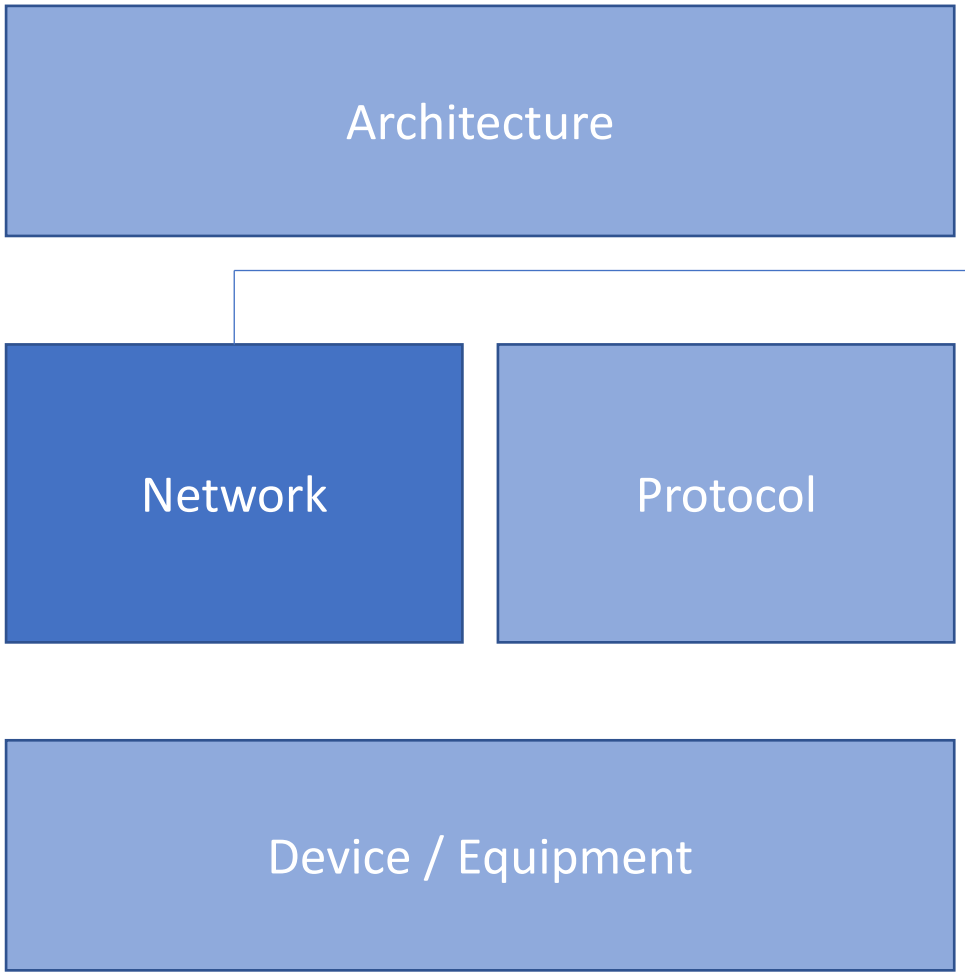
Recap



Provide visibility as foundational problem:

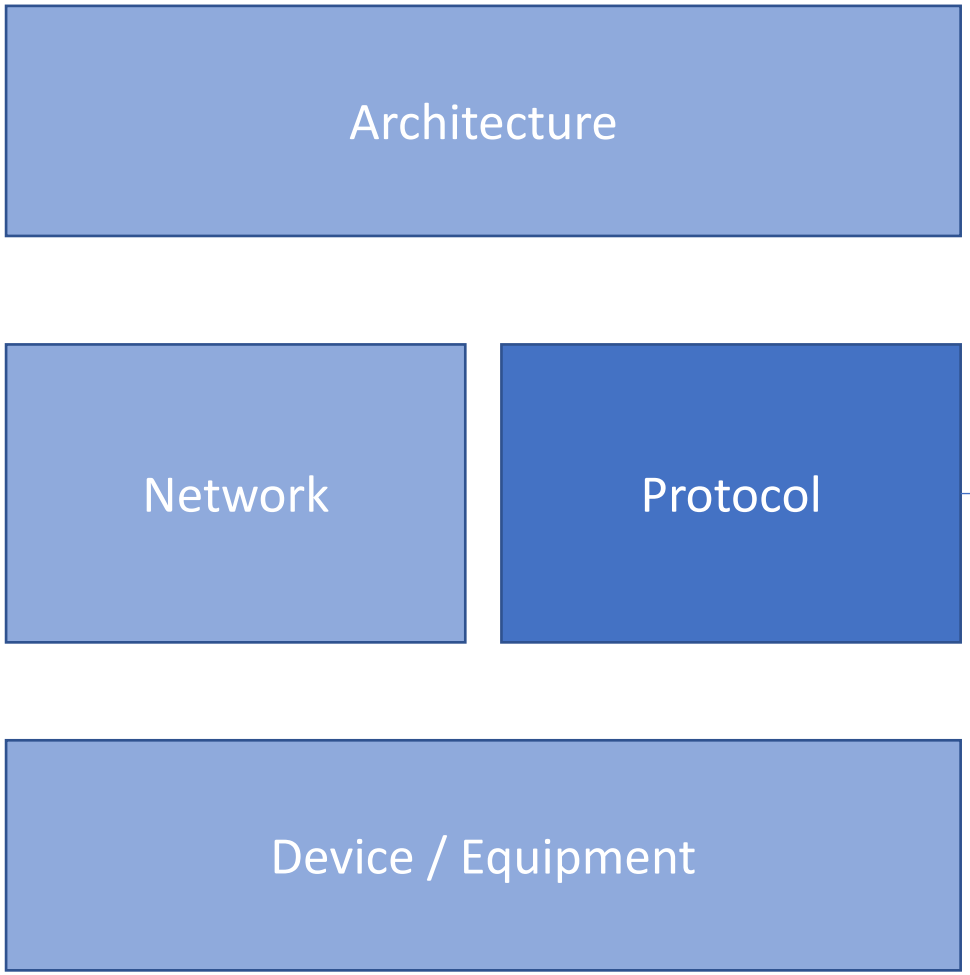
- **Assess usage, validate effectiveness**
- **Enable control loops** for energy/sustainability optimization schemes
- Requires **Instrumentation for energy metrics**
- Companion draft: Green Networking Metrics (draft-cx-green-metrics; https://datatracker.ietf.org/doc/draft-cx-opsawg-green-metrics/)
- Selected challenges+opportunities
  - Certification and compliance assessment methods
  - Virtualized energy and pollution metrics
  - Accounting for energy mix, energy sources
  - Fair carbon footprint attribution to flows & paths

Recap



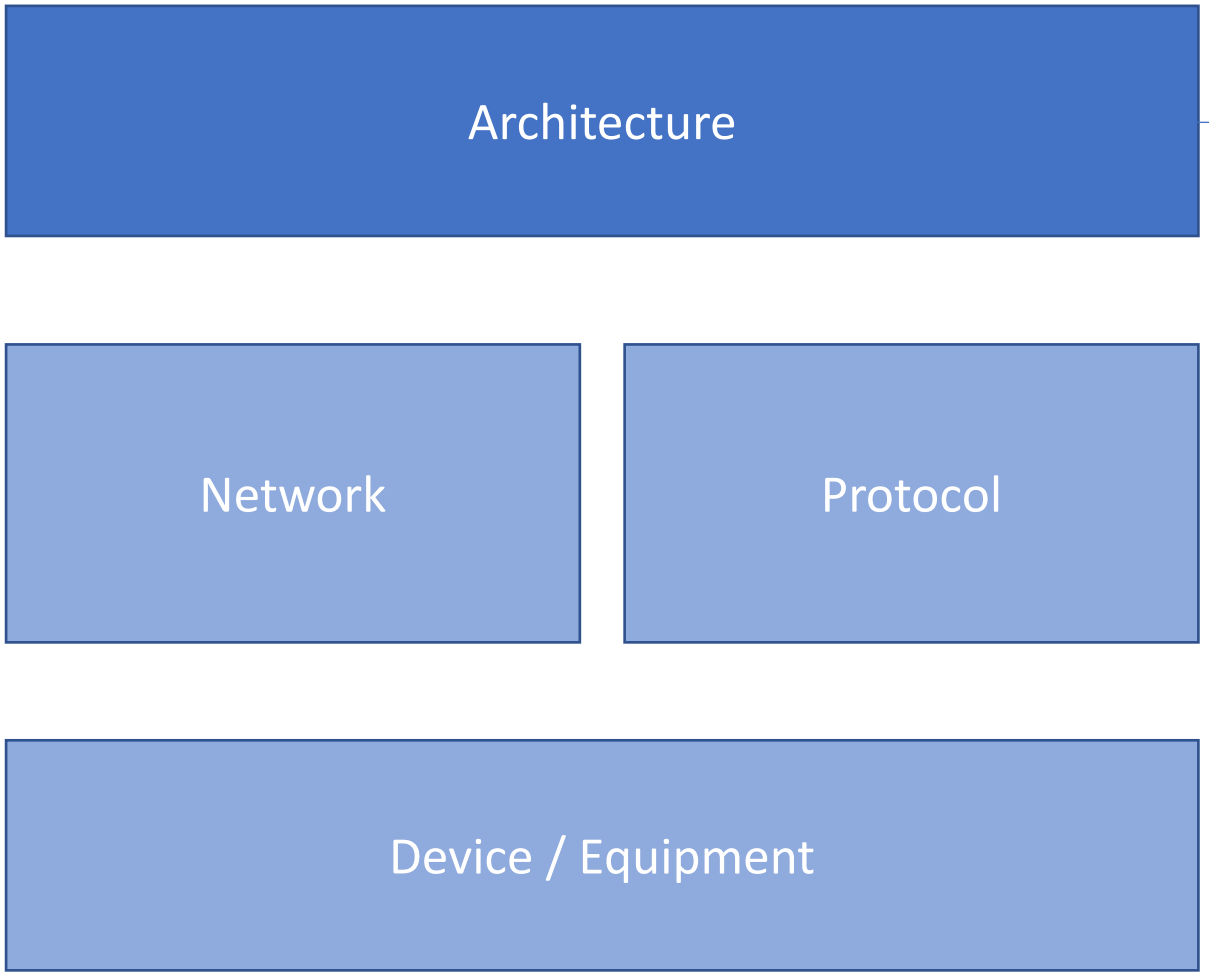
- **Network optimization**
  - Energy/carbon/pollution-aware routing & path configuration
  - Deployment / placement of VNFs
  - Optimize carbon footprint while maintaining other goals
  - AI and ML methods
  - Applicability of game-theoretic approaches
  - “Control knobs” for intent-based tradeoffs
- **Energy-related control protocol extensions**
  - Energy as a cost factor – in IGP, SDN controllers
  - Assess carbon intensity of paths, optimize networks to minimize overall footprint
- **Carbon-aware traffic steering** to steer traffic along greener paths
- **Green abstractions** taking into account memory, processing, transmission

Recap



- **Protocol enablers for 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 autonomics? of IBN?
- **Protocol optimization**
  - Traffic adaptation (e.g. bursty vs smoothened transmission to maximize efficiency;
    control knobs for carbon-aware traffic pacing)
  - Data volume reduction
    (e.g. codings, efficient retransmissions)
- **Network addressing and deployment**
  (e.g. smaller tables to maintain)
- **Instrumentation** (again)
  e.g. energy telemetry at flow & path level

Recap



- **Facilitate organization of networking applications** to minimize energy consumption
- **Holistic carbon impact assessment methods** for alternative approaches
- **Examples**: retrieval of content, computation placement (compare CDN/ICN/COIN but from energy perspective)

Notes & discussion

- Next steps: revise document per comments received
  - E.g. Kiran Makhijani: clarify taxonomy further – energy efficiency vs pollution metrics, some other refinements (e.g. level of granularity at which challenges need to be addressed)
- Companion draft-cx-opsawg-green-metrics is tackling green networking metrics
  - Involves considerable research challenges as well
    (e.g. virtualized energy, attribution of carbon footprint to flows, compliance/verification, …)
  - May be closer to standardization, hence in OPSAWG

Regarding feedback on green as NMRG topic

- What types of further contributions to work on in NMRG?
  - Carbon telemetry (solutions to assess footprint of a communications service including all factors – requires end-to-end model, ability to snapshot telemetry along a path, etc)
  - Network carbon optimization as a use case for AI (tieing the two together) - e.g. path optimization, function placement (carbon-efficient DC vs less carbon-efficient edge, etc) (facilitated by ML)
  - Enablers for energy savings mechanisms – e.g. retention of certain state to facilitate fast discovery and reconvergence
  - Green Intent and control knobs to navigate tradeoffs

THANK YOU!

Comments? Questions? Please contact us

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