Side Meeting at IETF116, Yokohama, Japan
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Challenges and Opportunities in Green Networking

https://datatracker.ietf.org/doc/html/draft-cx-green-ps-02

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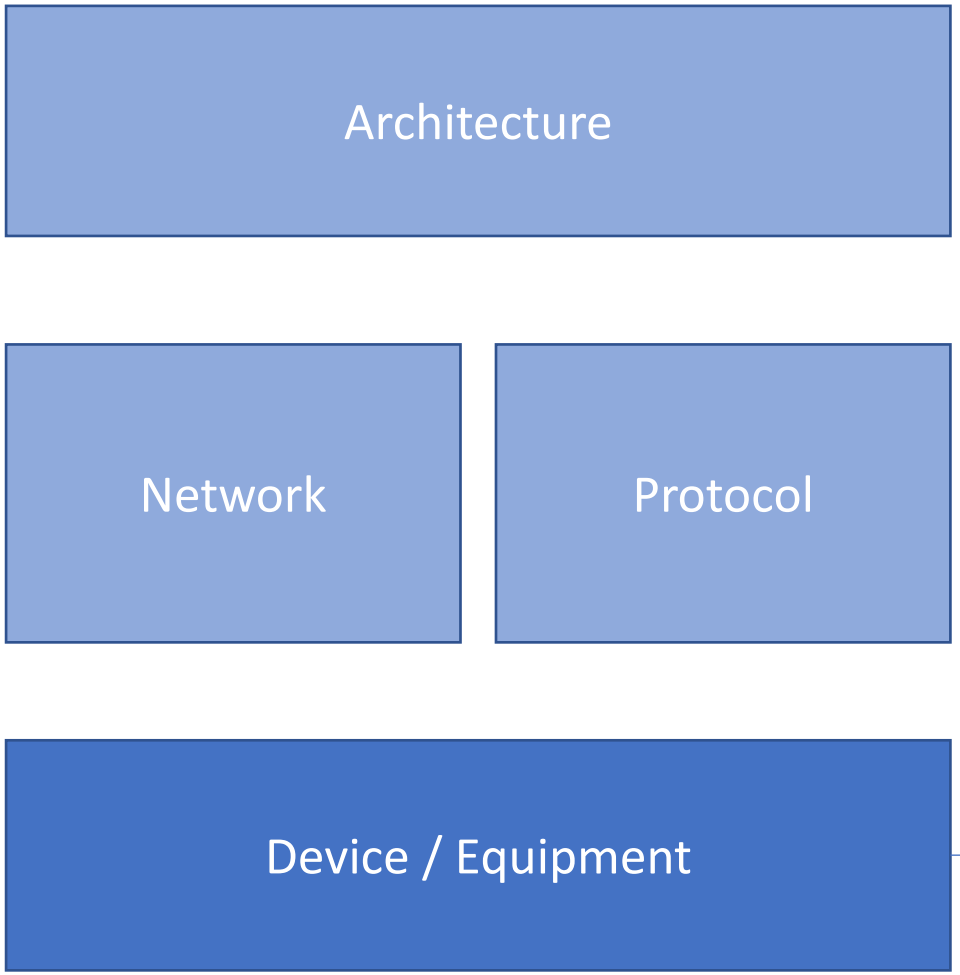
I.D. “Challenges and Opportunities in Green Networking”
https://datatracker.ietf.org/doc/draft-cx-green-ps/

- 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
  - Corresponding challenges and opportunities analyzed & identified in this draft
- NMRG as landing spot
  - Concerned with research challenges, not specific solutions
  - Solutions can result in actionable items for IETF
  - In large part, identified challenges and opportunities are management-related

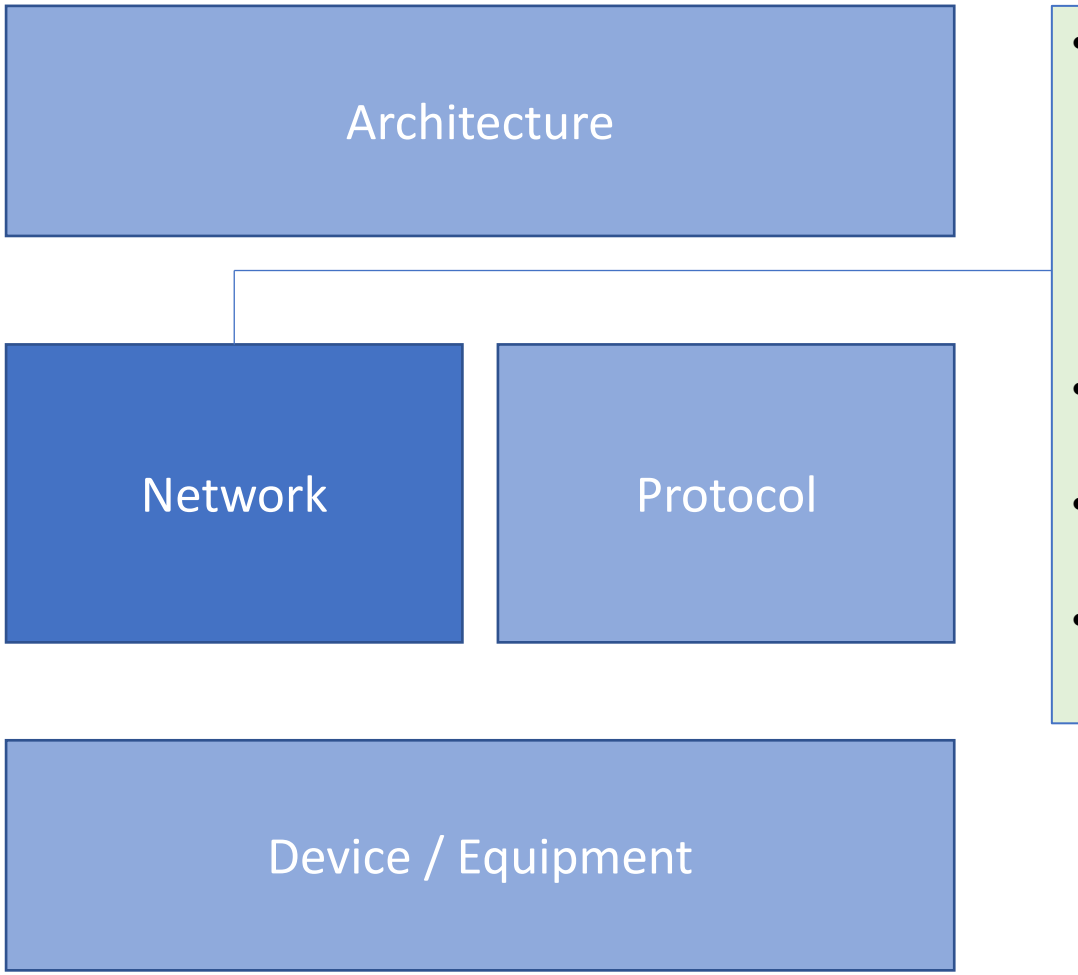
Overview 1/4



Provide visibility as foundational problem:

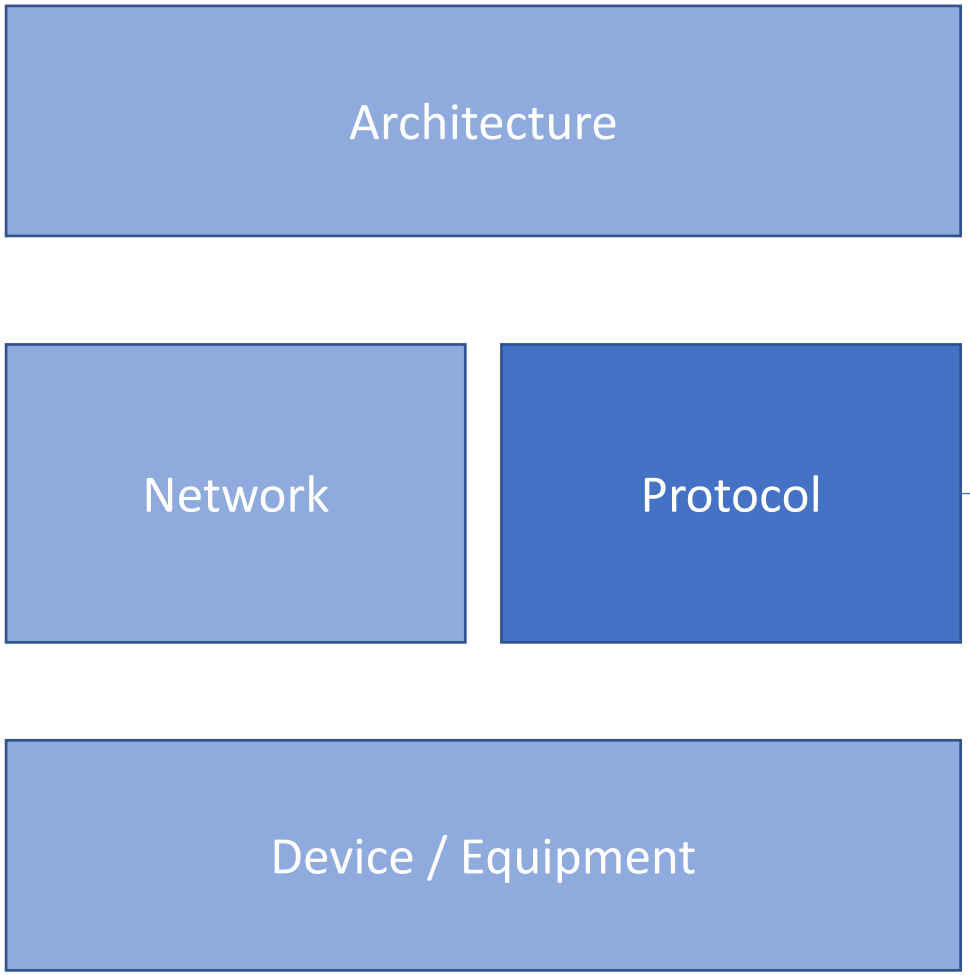
- **Assess usage, validate effectiveness**
- **Enable control loops** for energy/sustainability optimization schemes
- Requires **Instrumentation for energy metrics**
- Companion draft: Green Networking Metrics (draft-cx-green-metrics; https://datatracker.ietf.org/doc/html/draft-cx-green-ps-02)
- Selected challenges+opportunities
  - Virtualized energy and pollution metrics
  - Accounting for energy mix, energy sources
  - Fair carbon footprint attribution to flows & paths
  - Certification and compliance assessment methods
- Outside scope: hardware advances, transmission technology, etc

Overview 2/4



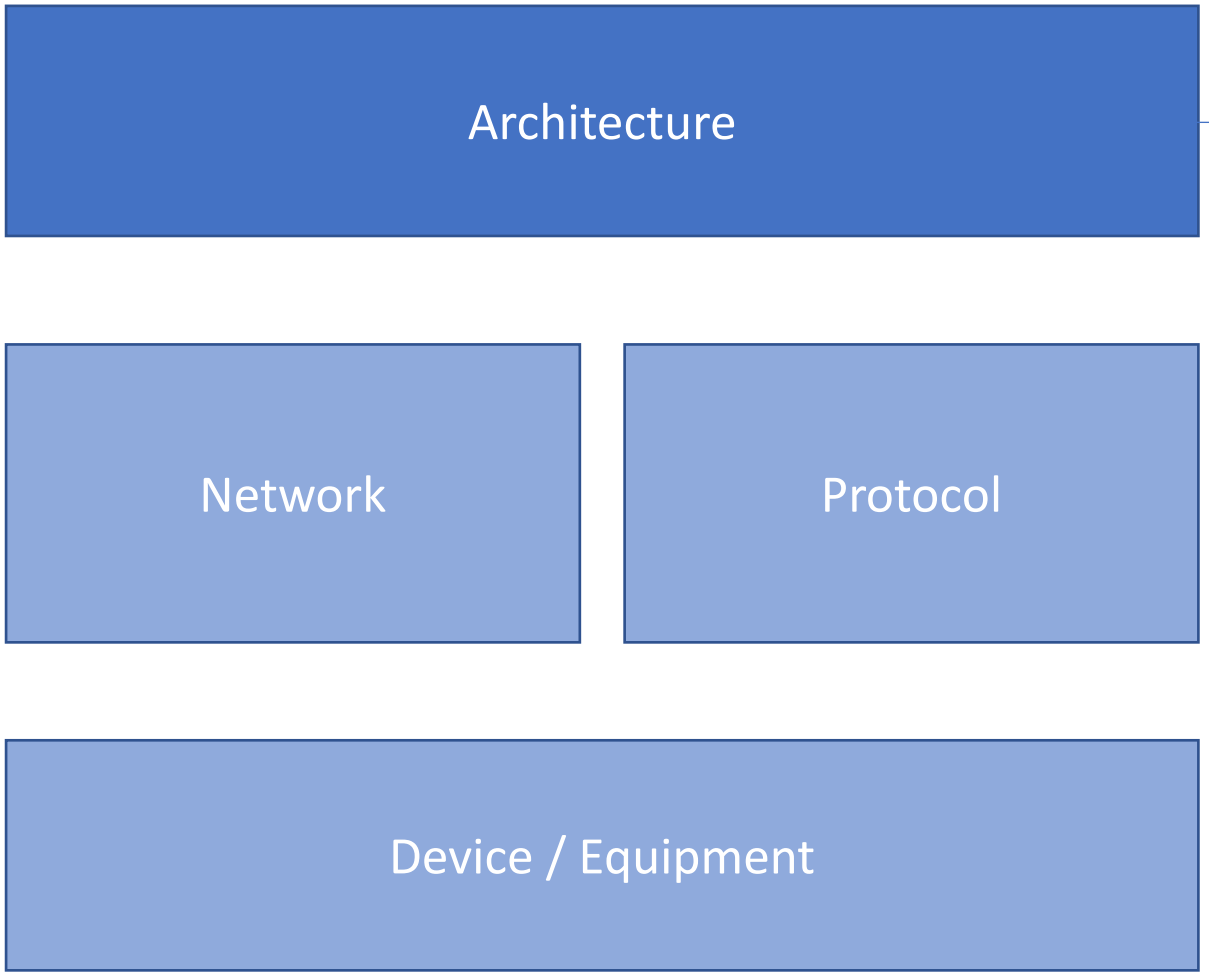
- **Network optimization**
  - Energy/carbon/pollution-aware routing & path configuration
  - Deployment / placement of VNFs
  - Optimize carbon footprint while maintaining other goals
  - AI and ML methods
  - Applicability of game-theoretic approaches
- **Carbon-aware traffic steering**
  to steer traffic along greener paths
- **Green abstractions**
  taking into account memory, processing, transmission
- **Autonomics and IBN** for Sustainable Networking
  - “Control knobs” for intent-based tradeoffs

Overview 3/4



- **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
- **Energy-related control protocol extensions**
  - Energy as a cost factor – in IGP, SDN controllers
  - Assess/monitor carbon intensity of paths, optimize networks to minimize overall footprint
- **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

Overview 4/4



- **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)

Discussion

- 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: resources vs utilization vs service levels, caching versus access, etc
  - … and management control loops
- NMRG adoption has been requested
  - Impactful subject where network management can make important contributions
  - Topic involves many open research questions, coupled with ability to identify standardization opportunities
  - Makes IRTF/NMRG an excellent candidate

THANK YOU!

Comments? Questions? Please contact us

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