

# Heterogeneous Networks

# Findings, Discussions, and Recommendations in Several Areas

- Access to Media
  - Access to RF spectrum
  - Access to dark fiber
- Heterogeneous network interfaces
- Future or New-Generation networks

# RF Spectrum

- Finding:
  - Access to RF spectrum is limited, highly fragmented inside and outside national boundaries, and (in the US) is very constrained by military allocations
  - This creates almost insurmountable barriers to next generation RF R&D
  - Exacerbated by commercial providers “walled garden” approach to segmenting off their markets
  - Current demand for MSI spectral space (802...) has far exceeded available spectrum space

# Discussion

- National and commercial “walls” guarantee lack of true mobility in the large scale
  - Intelligent or cognitive radio can alleviate some, but not all of these problems
- RF congestion has become such a problem (particularly in the US) that US R&D efforts are at a competitive disadvantage

# Recommendation

- The “educational” TV spectral allocation in the 2.4 – 2.6 Ghz band be opened up for R&D

[need example applications that this would enable]

# Dark Fiber

- Finding:
  - The general “drying up” of access to dark fiber in the US is preventing not-for-profit R&D
- Discussion:
  - Without access to all layers, the most general research is impossible for US researchers
- Recommendation:
  - As the US mandates creation of new High Voltage transmission line rights of way, it should make provision for National Lab-scale fiber infrastructure

# Heterogeneous Networks

- Finding:
  - Heterogeneous networks (which by definition span technologies) suffer at the technology interfaces
  - Data transformation or adaptation is frequently required

# Discussion

- Management information exchange across domain or administrative boundaries is inadequate to achieve end-to-end: path, link, or application optimization
  - This makes Service Oriented Architectures (SOA's) almost impossible to implement
  - Examples include:
    - Mobility, walled garden markets, and security

# Discussion Cont.

- Performance measurement (either for control plane feedback, or application feedback) is inadequate and ill-defined
  - Example – TCP always assumes loss = congestion
- Need span-by-span link state information (lost packets, etc.) in a useable form
- Need useful information even in a partially hidden (domain-referenced) environment
- Range of issues beyond any single workshop

# Recommendations

- National Coordination office (working with all constituent agencies) should consider sponsoring a series of new or next generation network workshops
  - Technology-bridging protocols
  - Self-adaptive protocols
  - Control and management in the context of partially hidden link-state information
  - End-to-end security in heterogeneous networks
  - Advances in the physics and engineering of new network devices

# Recommendations Cont.

- National scale testbeds need to be extended to both ends of the heterogeneous/technology spectrum including RF and Fiber
- National scale testbeds need to support transparent development from the application to the infrastructure layer

[Meta comment – this group needs to capture relevant output from other sessions, including security and network science and engineering.]