



INTERNET OF THE FUTURE

Challenged Networks

The Mobile Internet is Not Connected

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Defining Challenged Networks

- ▶ Communication environments where (conventional) expectations of link or path characteristics no longer hold
- ▶ Network constraints
 - Long communication delays
 - Unstable/unpredictable links
 - Non-existent end-to-end paths
 - Very low data rates
 - High error rates
- ▶ Node constraints
 - Computational and storage resources
 - Energy
- ▶ Widespread with mobile nodes and in remote regions



Dealing with Challenged Networks: Examples

- ▶ Identifying the challenged link and concealing the challenges
 - Suspend-resume transport + performance enhancement for the challenged link
 - Applications: mobile Internet access
 - Areas: transportation (car, bus, train, ...)
 - Limitations: unaware applications, abstractions leak, constrained scenarios

- ▶ Application-specific solutions
 - Often vertical integration (cross layer designs, hop-by-hop application routing, ...)
 - Applications: sensing, information sharing, ...
 - Areas: sensornets, mobile applications (MANETs), overlays
 - Limitations: assuming special purpose devices, creating islands, Internet integration

- ▶ Delay-tolerant Networking (DTN)
 - Asynchronous message-based store-carry-and-forward communication
 - Applications: sensing, remote control, interpersonal interactions
 - Areas: space communications, underwater, MANETs, message ferrying
 - Limitations: asynchronous applications, many open issues, Internet integration



Some Research Directions

- ▶ Networking architectures supporting challenged networks
 - Beyond mobile users attached to the network infrastructure
 - Accepting discontinuous connectivity as a basic premise
- ▶ Revisiting application protocol design
 - Eliminating the (often artificial) dependency on always-on connectivity
 - All the way to application interaction paradigms and user interfaces
- ▶ New transport paradigms
 - Robustness as another dimension of reliability
 - Refining MTU and end-to-end?
- ▶ Suitable operating systems support and network APIs
 - Creating awareness about the network (rather than too much abstraction)
 - Better control of the network and transport protocol machinery
- ▶ Foster experimentation and experience