
Re-Thinking Communications

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- Public Internet continues to grow
 - 1.3B users, 540M hosts, 1B devices, .5B mobiles
- Edge and core speeds at 10-40Gb/s moving to 100 Gb/s
- Geographical indexing and display of data (Google Earth, etc)
- Video support (10 hours of YouTube uploaded/minute)
- Convergence (IM, Skype on all platforms)
- Rapid application evolution (Java, JavaScript, etc.)
- IPv6 deployment (slowly but 2010 IPv4 exhaustion helps)

Regional Internet Statistics - 2008



Region	Internet Population	% penetration
Asia	510.5 Mil.	13.7 %
Europe	348.1 Mil.	43.4 %
North Am.	238.0 Mil.	71.1%
LATAM/C	126.2 Mil.	22.2 %
Mid-East	33.5 Mil.	17.4 %
Oceania	19.2 Mil.	57.1 %
Africa	44.4 Mil.	4.7 %
TOTAL	1,320 Mil.	20.0 %

- Security Sucks (DDOS, Viruses, Worms, Trojan Horses, Spam)
 - Browser ingestion of malware (drive by downloads)
 - Key management a pain
 - Abandoned in field (too awkward, too sluggish)
- Poor use of broadcast media (e.g. turns WiFi into pt-pt)
- Too much pre-configuration and set up
- TCP/IP fragile in disrupted or highly delayed conditions (tactical mobile)
- Pre-allocated spectrum, poor utilization, congestion, interference

- Semantic Web
- Complex objects that can only be rendered via computer
 - 3D interactive objects
 - Complex spreadsheets
 - Interactive environments
- BIT ROT!
 - Preserving interpretive programs (Windows 3000 and PPT 1997)
 - And the operating systems that run them
 - And the hardware that run the operating systems
 - For thousands of years!!

Is the Acquisition Process Broken?



Over-dependence on requirements specification

Little ability to field test preliminary designs and iterate

Time lines virtually guarantee out of date technology

Is there too much focus on single final winners? Can standards permit multiple sources better?

What to do? (it isn't easy)



- Frequency and waveform agile radios
- Spectrum sharing algorithms
 - Automatic power management
 - Jump-aside on interference detection
- Delay and Disruption Tolerant Networking (DTN)
- Content cacheing, content-based routing
- DARPA-style rapid development and testing
- System-level resilient architectures
- Self-configuration, strong authentication

- (NSF)Future Internet Design (FIND)
 - Authentication, Integrity, Confidentiality, Mobility,
 - Datacasting, Cacheing, Multihoming (separate end point ID from routing)
- (NSF, DARPA) Self-configuring (Sensor) Networks
 - CENS (UCLA)
 - MANET (DARPA)
- (NASA, DARPA) Delay & Disruption Tolerant Networking



DTN Phase 2 Results



- **Demonstrated Enhanced Reliability in Military Scenarios**
 - 100% message delivery across SATCOM and heterogeneous networks
- **Demonstrated New Capabilities**
 - Reliable On-The-Move to On-The-Move Over the Horizon Comms
 - Reliable delivery when the destination is disconnected / unknown
 - Reliable delivery to units who don't need the information now, don't know they will need the information, but *will* need the information later
- **Demonstrated Lower Bandwidth for Given Number of Tracks**
 - 5x reduction in required bandwidth for tactical application
 - 3.5x increase in capacity over tactical radio
 - ⇒ *Potentially up to 17x capacity increase for typical military applications .. savings should extrapolate to other client-server apps*
- **Demonstrated Networking without Infrastructure**
 - Delivery from edge caches *further* reduces demands on long-haul tactical links
 - Delivery without servers or pre-established names, roles, nets, ...



DTN Phase 2 Results (2)



- **Demonstrated robustness thru 2000 hours of operation in DieselNet (GaTech/UMass), 1500 hours of operation in ElevatorNet (BBN)**
- **Worked with DTNRG to Stage DTN Specifications thru IETF Process towards RFCs – Critical to COTS/vendor Strategy**
- **DTN Implementations Interoperated at IETF Nov 2006 – new interop today**
- **Demonstrated DTN operation in scenarios modeled on service CONOPS, Nov 15th at Fort AP Hill, following 3 weeks of field exercises**

**DTN Delivers Information from the Edge, to the Edge –
Reliably & WHEN It's Needed**



Summary of Military System Exercise Results at Fort AP Hill



- **Showed that DTN integrated into tactical comms provided reliability & forwarding**
- **Achieved 100% OTM message delivery across SATCOM with existing military procedures**
- **Demonstrated superior reliability of DTN vice end-to-end TCP across long comms outages**
- **Demonstrated reliable OTM edge-to-edge comms using alternate routing to advantaged node**
- **Demonstrated military app retrofitted with DTN for reliable delivery**
- **Demonstrated bandwidth savings using (reliable) state at both ends of connection**
 - 4.7x reduction in application-generated network loading
- **Demonstrated 3.5x capacity improvement in tactical network**
 - Potentially 17x capacity improvement similar applications over tactical networks

DARPA, DISA, NSF, NASA Team?



Resurrect the FRICC (Federal Research Internet Coordinating Committee - group of program managers)

Combine:

- DARPA radios

- DISA Shared spectrum allocation (experimental)

- NSF University research program(s)

- NASA/DARPA open source DTN software

Target: serious integration of tactical communication into Internet