DTN Fundamentals

DTN => Delay- and Disruption-Tolerant Networks/Networking

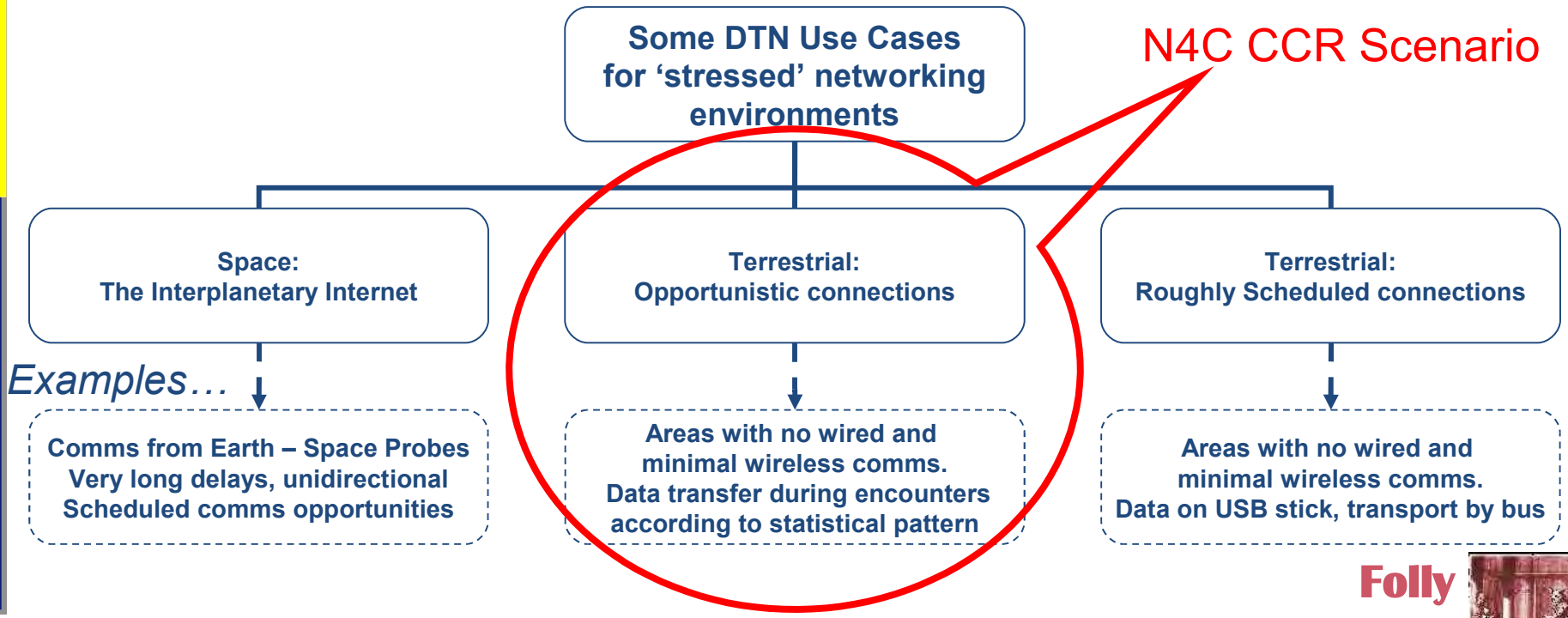
Why do we need DTN?

'Conventional' Internet assumes

- short end-to-end delays
- fairly stable connections

Protocols (especially TCP) and many applications don't work well on networks that don't match these requirements

Often in Communication Challenged Regions (CCRs) neither is satisfied



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Store, Carry, and Forward

Scenario	Data Delivery Paradigm	Routing Mechanism
Conventional Internet (IP packet forwarding)	Independently handled packets with immediate forward or discard	Precalculated Routes using topology knowledge (via OSPF, BGP etc)
Email (RFC 5322)	Unitary Transfer of complete emails with Store and Forward at each intermediate hop	Overlay of configured links between (fixed) mail servers plus routing configuration
DTN (using RFC 5050 Bundle Protocol)	Unitary Transfer of 'Bundles' with Store, Carry and Forward at each intermediate hop node; nodes maybe mobile.. Hence 'carry'.	Depends on Use Case: Static Configuration, Schedule Oracle, Delay Tolerant Link State or (Un)Pruned Epidemic

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RFC 5050 Bundle Protocol

Bundles are complete encapsulated units of data delivered in a DTN, including

- The message data, either encrypted or not, according to requirements
- Addressing and routing control information
- Descriptive metadata, with extensible scheme in case extra is needed in future
- Optionally, security control information for encryption and/or integrity protection

Multiple instances of same bundle might exist concurrently in different parts of a DTN

Key features of a DTN using RFC 5050

- Custody-based retransmission for bundles
  - responsibility for delivery of a bundle can be transferred from sender to other willing nodes
- Ability to cope with intermittent connectivity
- Ability to take advantage of
  - Scheduled connectivity
  - Predicted connectivity
  - Opportunistic connectivity
  - (And also) Continuous connectivity
- Late binding of endpoint identifiers (EIDs or DTN addresses) to constituent (internet) addresses
  - The path a bundle takes through the network is **not** determined at the point it leaves the sender (unlike Internet)

Routing for DTNs

Mechanism	Description
Static Routing	Preconfigured, table based – specify either next hop or intermediate waypoint
Delay Tolerant Link State Routing (DTLSR)	Route calculation based on dynamically discovered topology. Unlike Internet LSR links can be potential rather than actual provided the overall topology is known in advance.
Scheduled (aka Oracle-based) Routing	A central Oracle provides all knowledge of what links will be available at what times allowing forwarding hops to be calculated and scheduled.
Epidemic Routing	Every bundle carried in a node is passed to every node that links to the carrier. Highly resource intensive!
PRoPHET Routing	A form of pruned epidemic routing. Statistical patterns in the mobility of nodes are used to reduce the demands on resoutces

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DTN Addressing

Addresses for a DTN use a Uniform Resource Identifer (URI) scheme

Basic scheme is ‘dtn:’

- Combines a node ‘identifier’ (similar to a DNS name), and
- Path information used to route bundles to applications.
- May also contain more complex information to support content-based or service based routing/delivery.

The dtn: scheme is still under development

There is also an ‘ion:’ scheme suitable for space based systems and scheduled routing

RFC 5050 DTN Implementations

N4C deployments are based on either:

- IRTF DTN Research Group coordinated DTN2 reference implementation, or
  - Information from http://www.dtnrg.org
  - Code available from http://code.n4c.eu or http://dtn.sourceforge.net
- Prophet implementation derived from previous SNC project
  - This implementation is based on an earlier version of the bundle protocol and is not compatible with DTN2.
  - Code available from http://code.n4c.eu

Other implementations exist. More information can be obtained from the DTN Research Group web site http://www.dtnrg.org

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More Information on DTN

'**DTN - The State of the Art**': N4C Deliverable D2.1 contains information about the history development and current experimentation with DTN. Downloadable from http://www.n4c.eu/Download/n4c-wp2-012-state-of-the-art-101.pdf

'Delay-Tolerant Network Architecture': RFC 4838 describes the overall architecture of DTN. Downloadable from http://tools.ietf.org/html/rfc4838

'The Bundle Protocol': RFC 5050 describes the basic bundle protocol used in N4C and elsewhere. Downloadable from http://tools.ietf.org/html/rfc5050

'**Functional Specification for DTN Infrastructure Software':** N4C Deliverable D2.2 describes the DTN2 reference implementation. Downloadable from n4c-wp2-023-dtn-infrastructure-fs-12.pdf

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