Saratoga update

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Thoughts on the evolution
of IETF transport protocols

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TSVAREA – Evolution of IETF Transport Protocols
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draft-wood-tsvwg-saratoga

- UDP/IP-based data delivery protocol. Draft now at version -14.
  - Initial -00 version of draft was May, 2007.
  - Related supporting drafts:
    - draft-wood-tsvwg-saratoga-congestion-control-04
    - draft-eddy-tsvwg-saratoga-tfrc-04
    - draft-wood-dtnrg-saratoga-13

- Discussed several times in DTNRG and TSVWG on lists and at group meetings, and at IETF69 TSVAREA, but have not yet asked for adoption.

  - Intent is to publish as experimental RFC matching the "flying code."

- Development continues via the *Saratoga* mailing list:
  saratoga-discussion@googlegroups.com

- Some code and related material is publically available:
  http://saratoga.sourceforge.net/

Saratoga is in operational use

- Disaster Monitoring Constellation: **http://dmcii.com/**
- Surrey Satellite Technology Ltd (SSTL) has used *Saratoga* since 2004 to download Earth imagery from multiple satellites:
  - initially 8.1 Mbps downlink, 9600 bps uplink, running at line rates.
    - path asymmetry of 848:1
  - SSTL's TechDemoSat-1, launching in 2014, has:
    - 400 Mbps downlink, up from 210 Mbps downlink now in flight.
    - *Saratoga* code conforming to current Internet-Draft.
- Cisco Systems has:
  - *Saratoga* implementation created for Square Kilometre Array effort.
  - funded *Saratoga* congestion control research at Uni. of Oklahoma.
- NASA has contributed:
  - Perl "reference implementation" used in interoperability testing.
- Charles Smith has contributed:
  - Wireshark decoder module for debugging implementations.
  - progress on development of C++ implementation for 64-bit Linux.

    http://saratoga.sourceforge.net/

8.1 Mbps — 2003

210 Mbps — 2011

400 Mbps — 2014
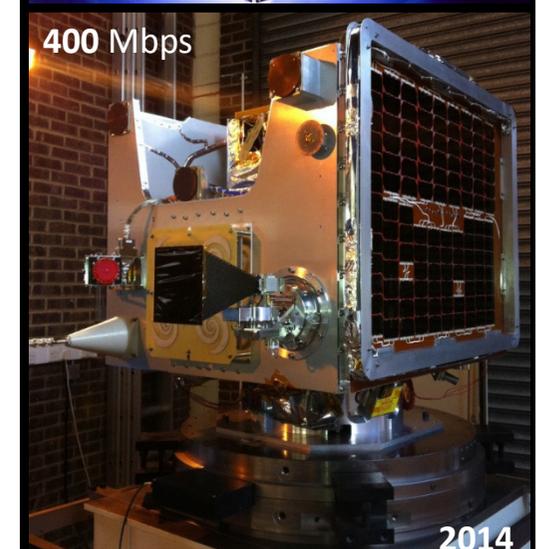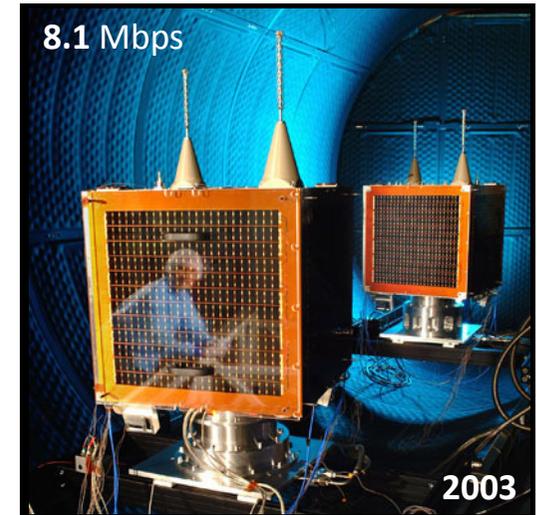
Background to *Saratoga*

- Reaction to size and slowness of an implementation of the CCSDS File Delivery Protocol (CFDP) being used for delivering images from first DMC satellite.
  - "CFDP Lite" later used on *Messenger* mission to Mercury.

- *Saratoga* version 0 developed at Surrey Satellite Technology Ltd (SSTL) by Chris Jackson, after scuba-diving the wreck of the *USS Saratoga* in Bikini Atoll.
  - Now used on Disaster Monitoring Constellation satellites.

- New version 1 created as a collaboration between SSTL, NASA, and Cisco Systems:
  - Originally thinking of IP-based bundle convergence layer for Delay/Disruption Tolerant Networking (DTN).
  - Now onboard SSTL's TechDemoSat-1.

- ***Saratoga* in daily operation from space *since 2004.***

US Navy — 1942

Bikini Atoll — 1946

Chris **Jackson** — 2003
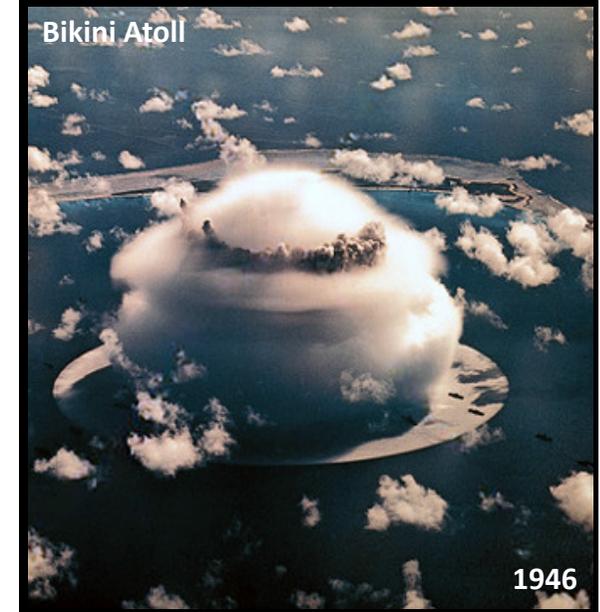
Saratoga characteristics relevant to evolution of IETF transport protocols

- **High performance over very high delays**
  - Bufferbloat measurements show cable delays are now similar to lunar RF propagation delay.

- **Works with high bandwidth asymmetry**
  - Uses SNACKs – Selective Negative ACKs
  - Feedback can be paced by explicit requests
  - TCP breaks with path rate asymmetry above 50:1 ratio. *Saratoga* can operate at *orders of magnitude* higher than that.

- **Flexible congestion control**
  - Current options: fixed-rate, TCP-Friendly.
  - Many other possibilities.

- **Runs over UDP for portability**
  - Implemented in "user space" or as tasks in a real-time operating system.

- **Has feature profiles for lightweight embedded implementations**
  - Example target is **small flight computers**.
  - Very relevant to **Internet of Things** (IOT).

- **Scales to yottabyte-size files for Big Data**
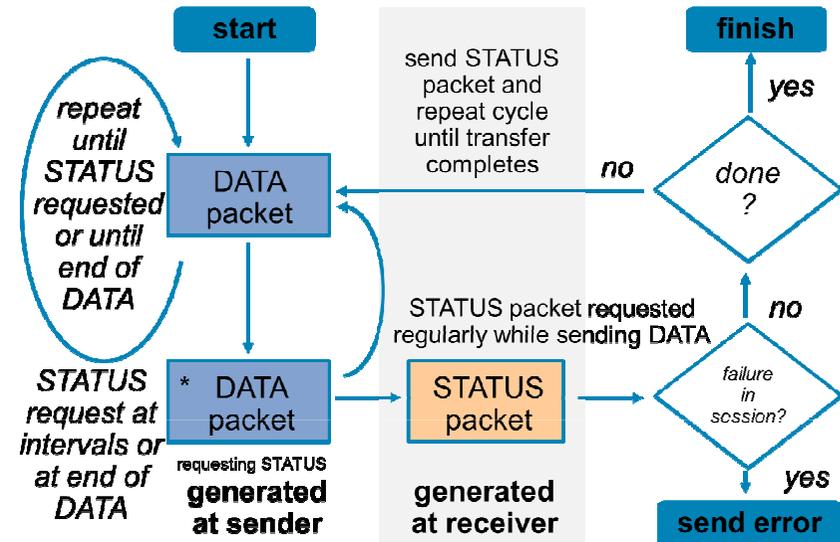
Evolving IETF Transport Protocols

- Can't keep defining "transport" as only TCP or UDP…
  - …or even as the Gang of Four: TCP, UDP, SCTP, DCCP.
- Transport protocols are where we implement end-to-end capabilities that are too difficult or too expensive to reproduce across *N* apps
  - Path MTU Discovery, transmission control, reliability, etc.
  - *Saratoga* is more a transport protocol than it is an application protocol…
  - …but contains notion of methods (GET, PUT, etc.) and data objects that are generally not associated with transport protocols.
    - CoAP, RELOAD are IETF APP and RAI protocols that contain a lot of typical transport functionality.
- **New IETF transports for the Internet** should **scale to high delays and throughput**, should **ACK efficiently**, should **support multiple congestion control algorithms**, and should be **runnable over UDP** for deployability through NATs in the real world.
  - ***Saratoga* shows that this is achievable.**

    http://saratoga.sourceforge.net/