Uses of end-to-end Scavenger Service

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TANA BOF IETF 72

July, 2008

Agenda

- Introduction
- VLBI : A high bandwidth service that needs a scavenger service
- Why network usage is moving in a direction that creates a business opportunity from scavenger services.
  - A look at Enterprise video

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Why Do We Need a Scavenger Service ?

- I have been interested in a scavenger service since ~2000. Why ?
- Bandwidth is expensive if you need a lot of it.
  - And some applications need a lot of it.
- Much Bandwidth is wasted in any network.
  - Especially true in the undersea fiber links, the most expensive bandwidth there is.
- Many very high bandwidth applications are not that sensitive to data loss (although they may not know it).
  - Digital Democracy : If one bit is as good as another, it is more efficient to sent more than to retransmit.

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Why Is there Bandwidth to Scavenge ?

- The TCP / IP Internet is good at filling up pipes.
- However, this decade has seen an increasing use of MPLS / VPNs to provide dedicated bandwidth, especially for enterprise customers.
  - These are replacing earlier point to point circuits such as SONET.
- These are typically sold with bandwidth and loss guarantees, and yet are generally not fully utilized.
  - They are typically not carrying web traffic.

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What is VLBI ?

- Very Long Baseline Interferometry
- How do you make a radio telescope 10,000 km across ?
  - You connect smaller ones…
  - At radio frequencies, telescopes the size of the Earth or larger are routinely synthesized.
  - The sensitivity depends on two basic things :
    - The size of your telescopes
    - The number of bits you record.
- Believe it or not, there are time sensitive applications of this
  - Earth rotation for GPS, Spacecraft Navigation, Transient Phenomenoma
  - In general, there are strong drivers for moving to real time "eVLBI"

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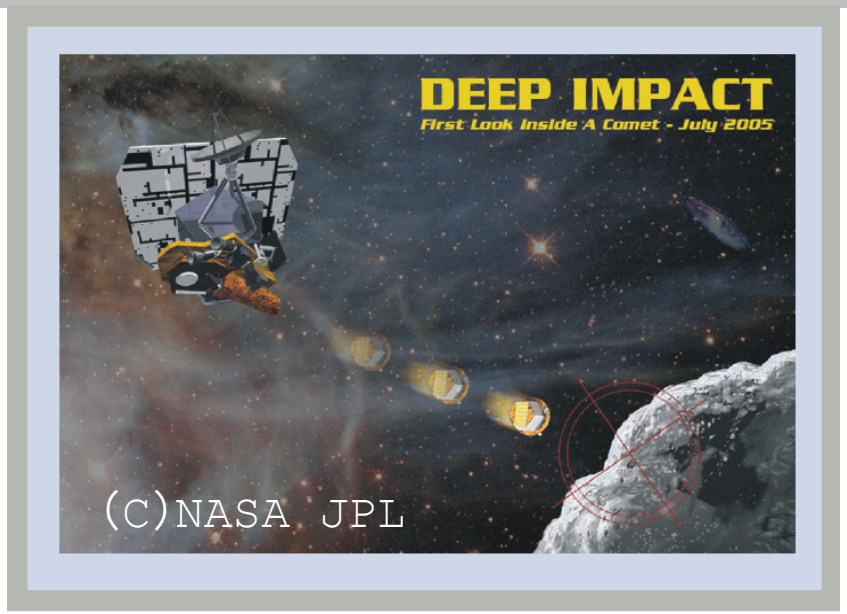
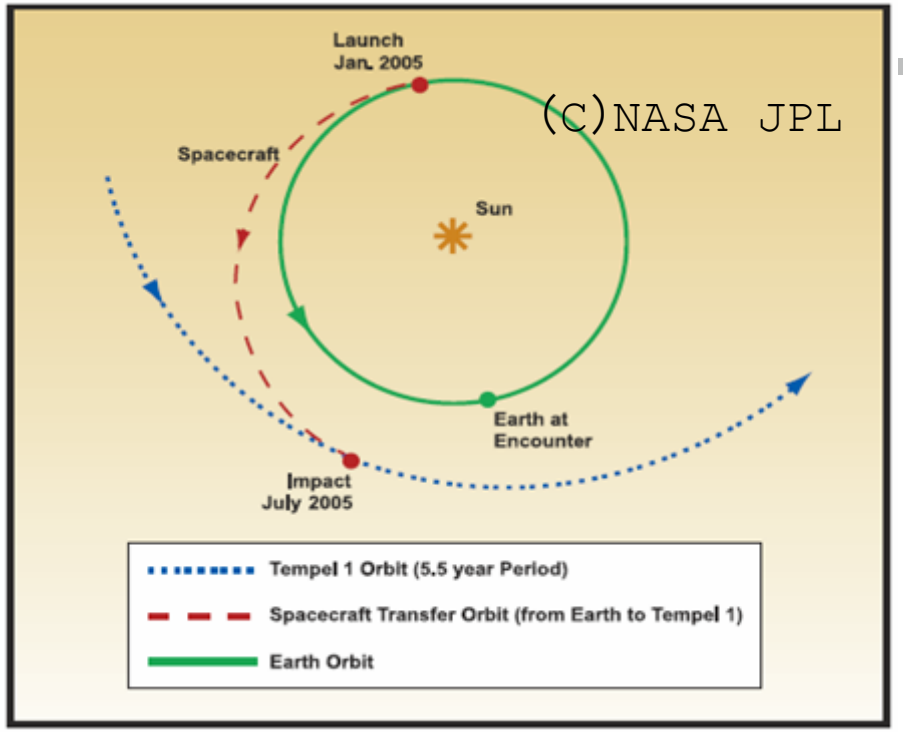
Contribution to Deep Impact mission

4 July 2005



http://deepimpact.jpl.nasa.gov/



Traveling at a relative velocity of 10 km/s and from about 864,000 km (536,865 miles) away, the impactor must strike the 6 km (3.7 mile) diameter comet.

- UT1 value provided by INT session
- eVLBI observations for IVS-INT2
- Data transfer for short time
- Contribution to the success of the mission

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Telescope sites participating

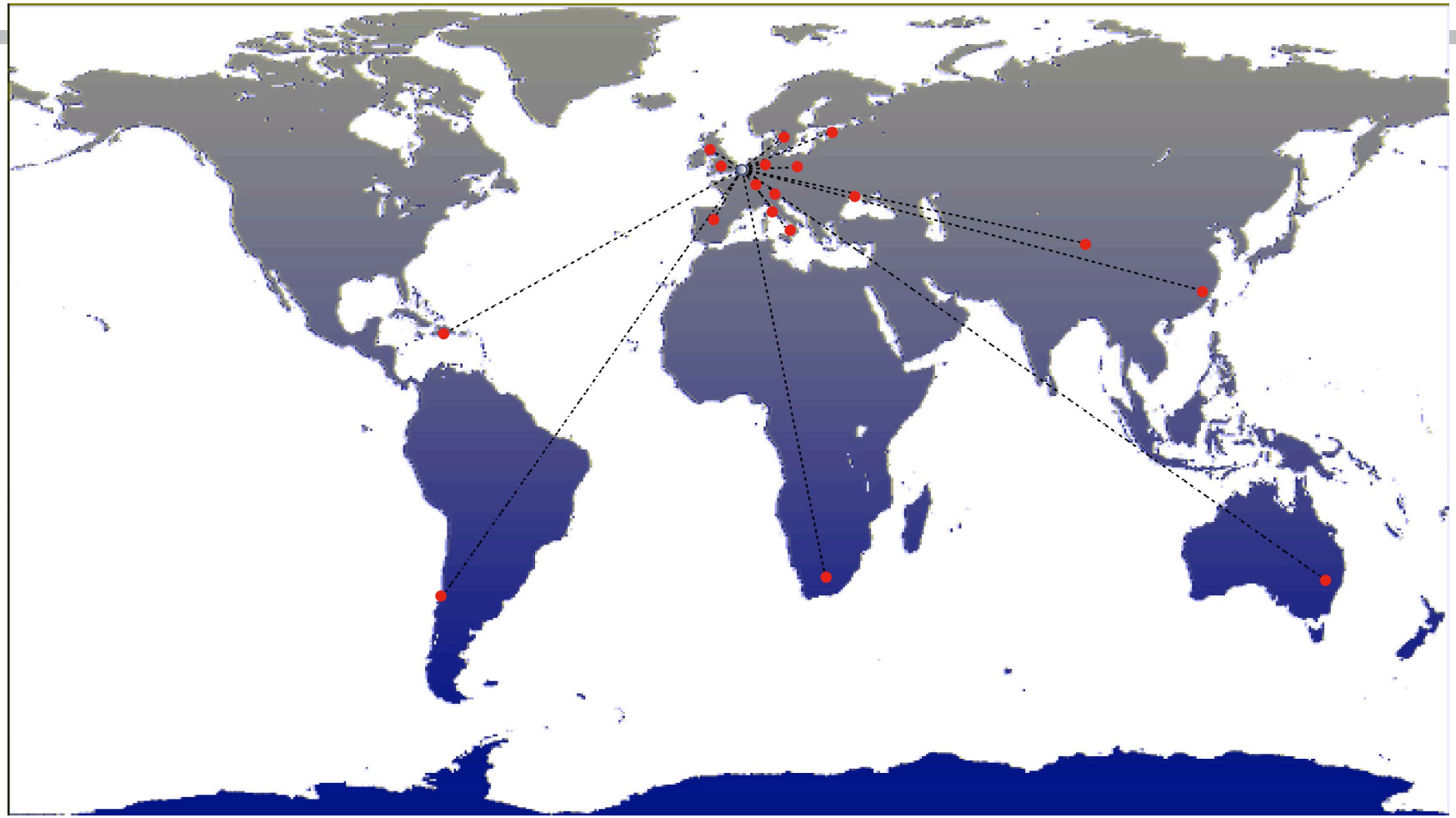

Image courtesy of Dr. Francisco Colomer, <http://www.oan.es/expres/status.htm>

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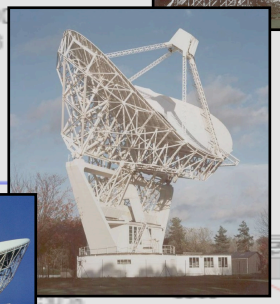
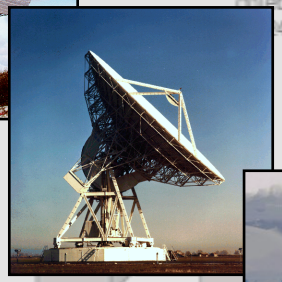
Routes across GEANT used by eVLBI MkVs

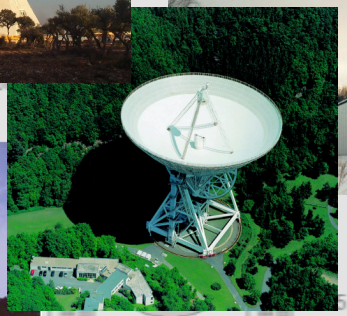




1 Gbps

155 Mbps

2.5 Gbps



10 Gbps

VLBI to eVLBI

- eVLBI : VLBI with electronic data transmission
- Characteristics :
  - High data rates (512 Mbps to 1 Gbps now, plans extend to 100 Gbps)
    - Can be real time, or quasi real time (transmit while the telescopes are moving) or to a buffer
  - Loss tolerant (up to ~ 1 % packet loss is OK)
  - Each sample is typically 1 or 2 bits (so one packet contains thousands of samples)
  - Typically Many to One (Telescopes to Correlator)
- The desire is to use as much of the existing IETF infrastructure as possible.
- The desire is also to spread the participating telescopes across the globe as widely as possible.

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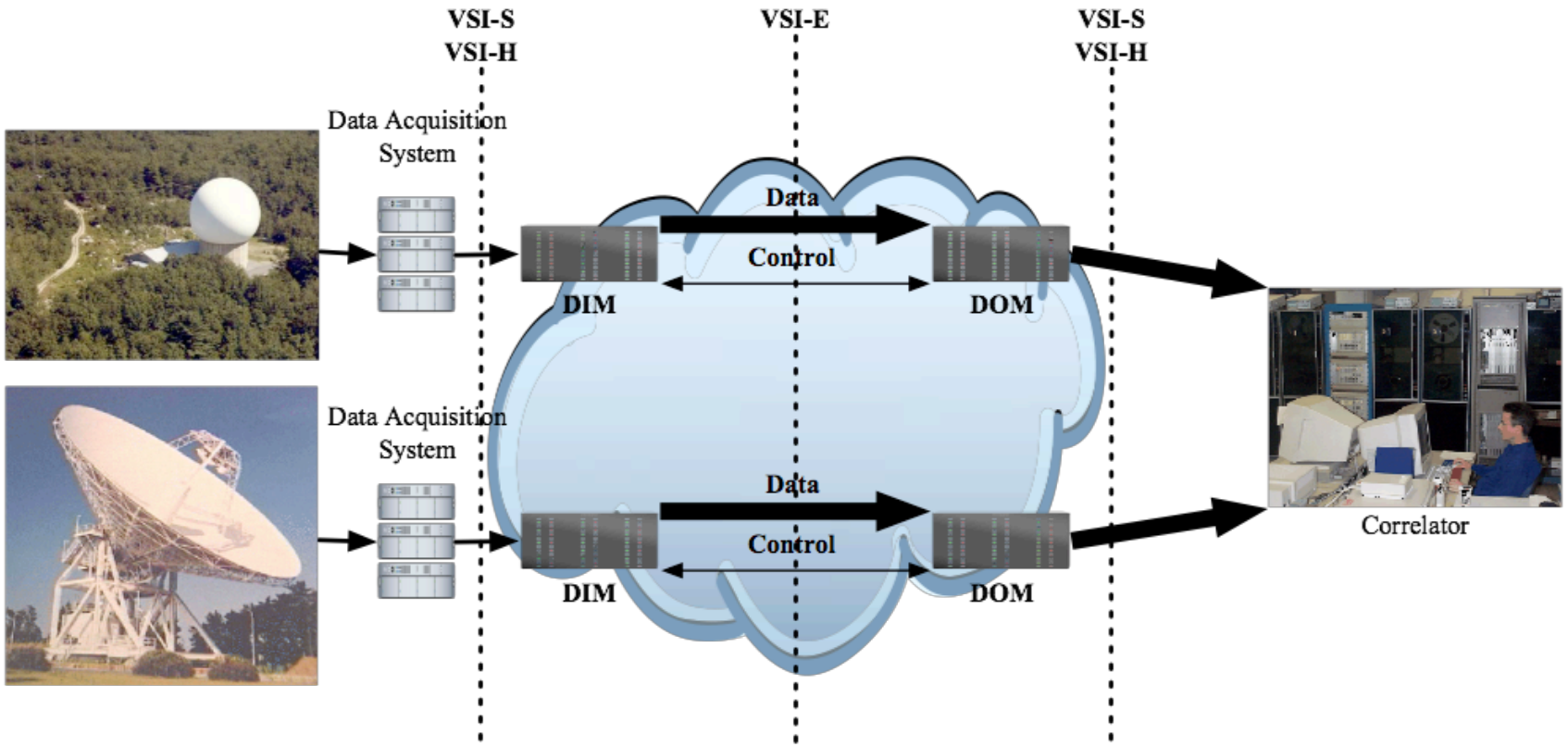
VLBI Standard Interface Data Flow



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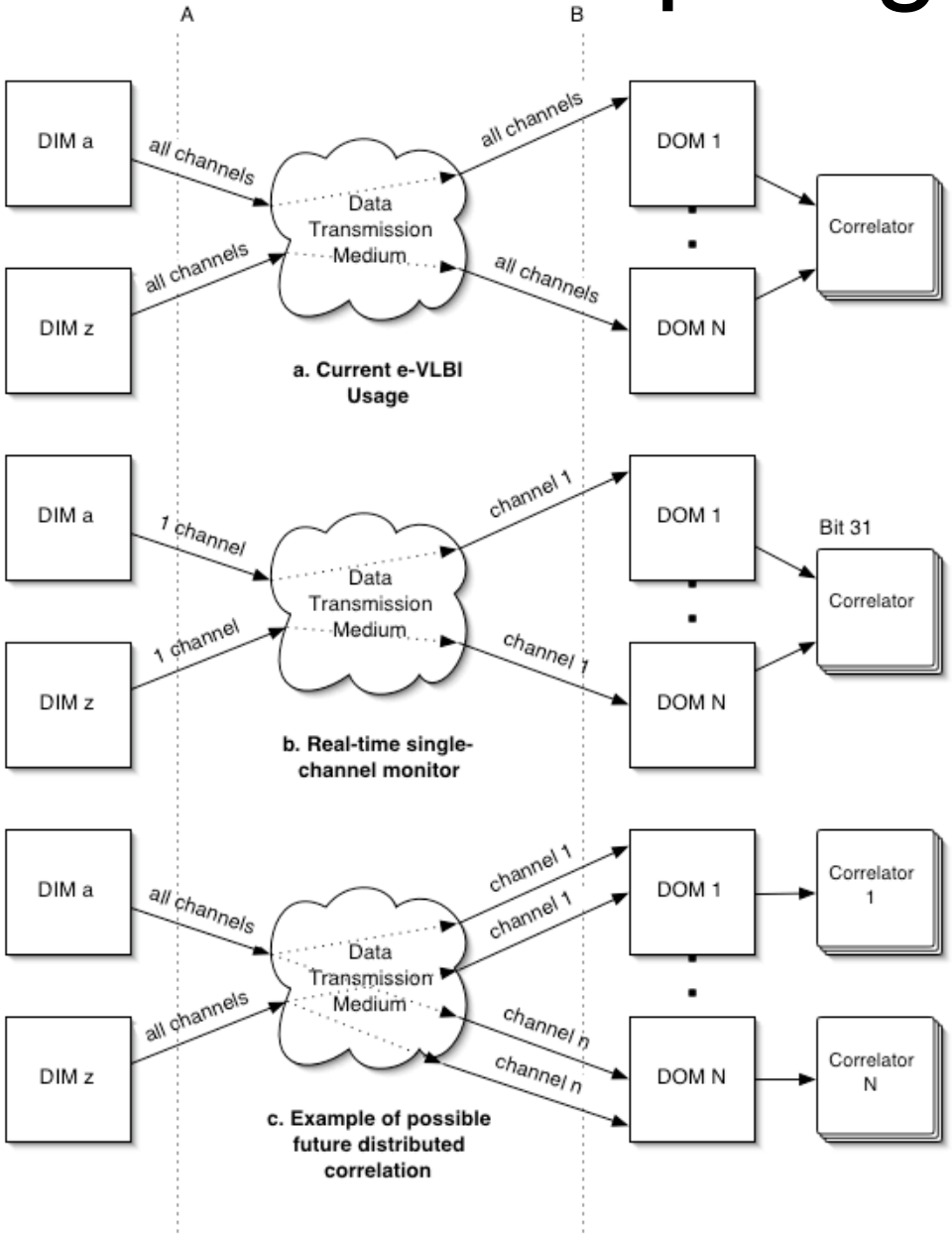
Network Topologies



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VLBI and a Scavenger Service

- The high data rates of VLBI make it an excellent candidate for a scavenger service.
  - They need as many bits as they can get
  - There is no need to retransmit any lost bits
  - There is a need to put telescopes at the end of long undersea fiber run

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Undersea fiber and a Scavenger Service

- Undersea fiber is the most expensive bandwidth that there is.
- It is a limited resource, it is expensive to lay and to light, and there is a great desire on the part of the operators to sell as much of it as possible.
- Enterprise VPNs are a good resource for a scavenger service (from the point of view of the operators).
- Let's look briefly at one such use, Telepresence.

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Telepresence in Use

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Bandwidth Provisioning

- Modern networks for Enterprise video are typically based on VPNs running over MPLS.
  - Telepresence, for example, typically requires at least 20 Mbps per site (full duplex).
  - The operator has to guarantee full bandwidth availability to the Enterprise, even though units may only be used a fraction of the day.
    - Telepresence / videoconferencing usage > 12 hours per day at any site is unusual.

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Full Mesh MPLS VPNs

- The evolving industry solution to the issues with point to point circuits involve MultiProtocol Label Switching (MPLS)
- This allows
  - Packets to be tagged so that flows between locations can be scheduled
  - Traffic engineering can be used to reserve / protect bandwidth between end points
  - The network can appear ***logically*** to be full mesh (connections between all end points) even though ***physically*** it is not.
  - This requires setting up tunnels between all possible end point pairs
    - For N end points, N (N -1)/ 2 tunnels
- Modern MPLS networks can pick up Diffserv Class of Service Code Point tags applied at the Telepresence unit itself.

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The Trouble with Full Mesh

- The trouble with Full Mesh MPLS is that the number of tunnels grows quadratically with the number of end sites
  - For 10 End Sites : 45 tunnels
  - For 20 End Sites : 190 tunnels
  - For 30 End Sites : 435 tunnels
- The more Enterprise end-sites, the less likely is each tunnel to be filled.
  - Yet the operator will have to provision bandwidth for each tunnel.
- There is a lot of bandwidth available in these VPNs for a scavenger service.

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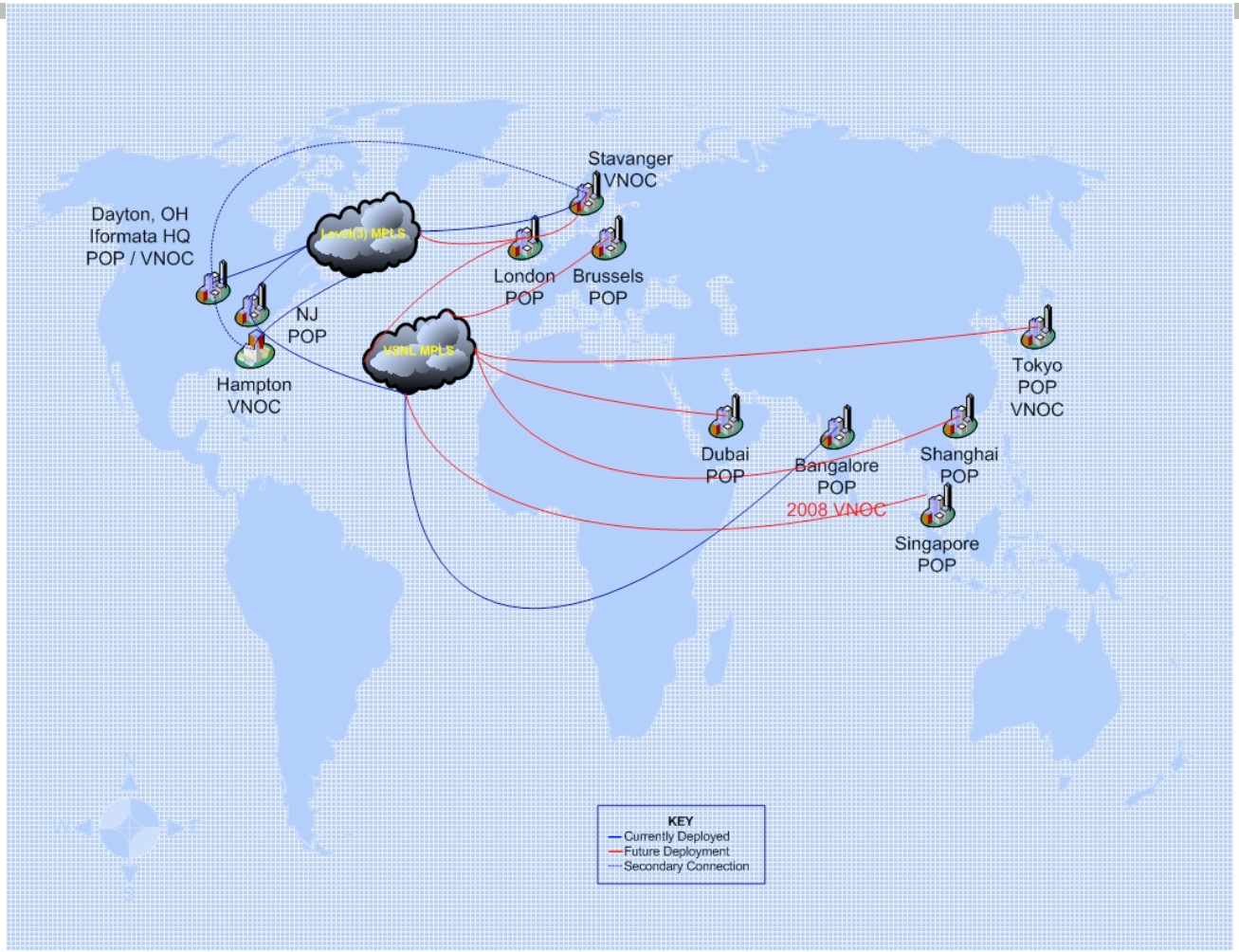
Telepresence VPN Map



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Video Code

- MPEG-4 is a late 1990's update to MPEG-2
  - Published 1999
- At the same time, the ITU was working on H.263+ / H.263+ + / H.26L standard extensions.
- In 2001, the ITU VCEG and the ISO MPEG joined forces
  - H.264 was published in 2003. It is also MPEG-4 Part 10 (not version 10!).
- H.264 seems to be the codec of choice for Telepresence going forward.
  - The Polycom RPX / HDX
  - Cisco Telepresence
  - HaiVision hai1000 codec

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Conclusions

- There are high-data rate applications that need a scavenger service.
- There is reason to expect that there is significant bandwidth for a scavenger service.
  - Even without VPN reservations, undersea fibers take time to light, and operators do not like to operate Internet links at > 50% capacity on a sustained basis.
    - Even the pure Internet bandwidth will have plenty of scavenger bandwidth.
- Widespread use of scavenger services is likely to cause a paradigm shift in some applications.
  - Do you really need to repair that bit ? Or just send another ?

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