

# **GOLE:** **Glif Open Lightpath Exchange**

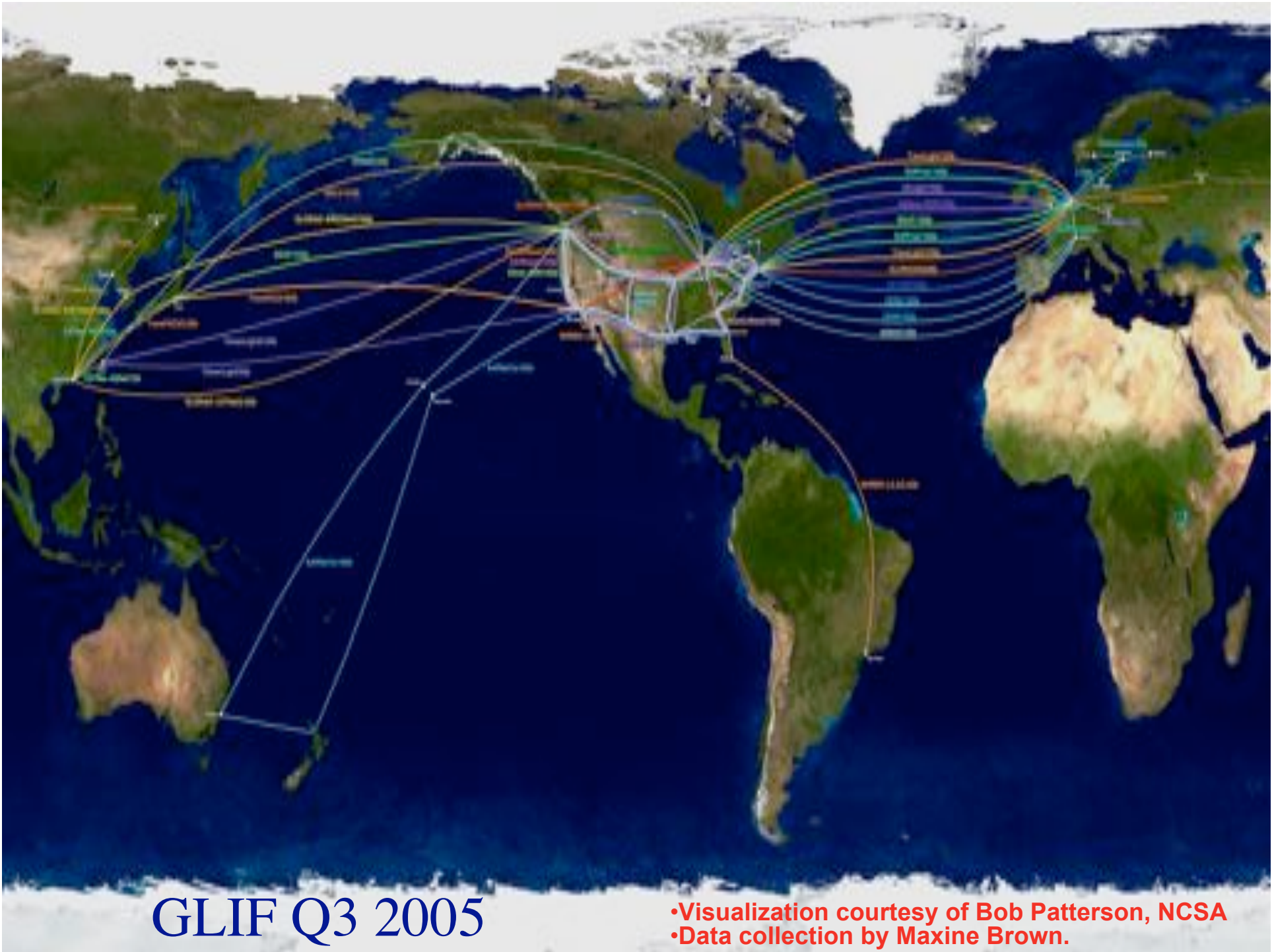
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# What is a GOLE?

- GLIF Open LightPath Exchange (GOLE) model
  - Place where hybrid networks meet to exchange traffic
  - facilitate international interconnections
  - minimize quantity of colo, equipment and cards required
  - minimize call blocking probability at optical exchange points

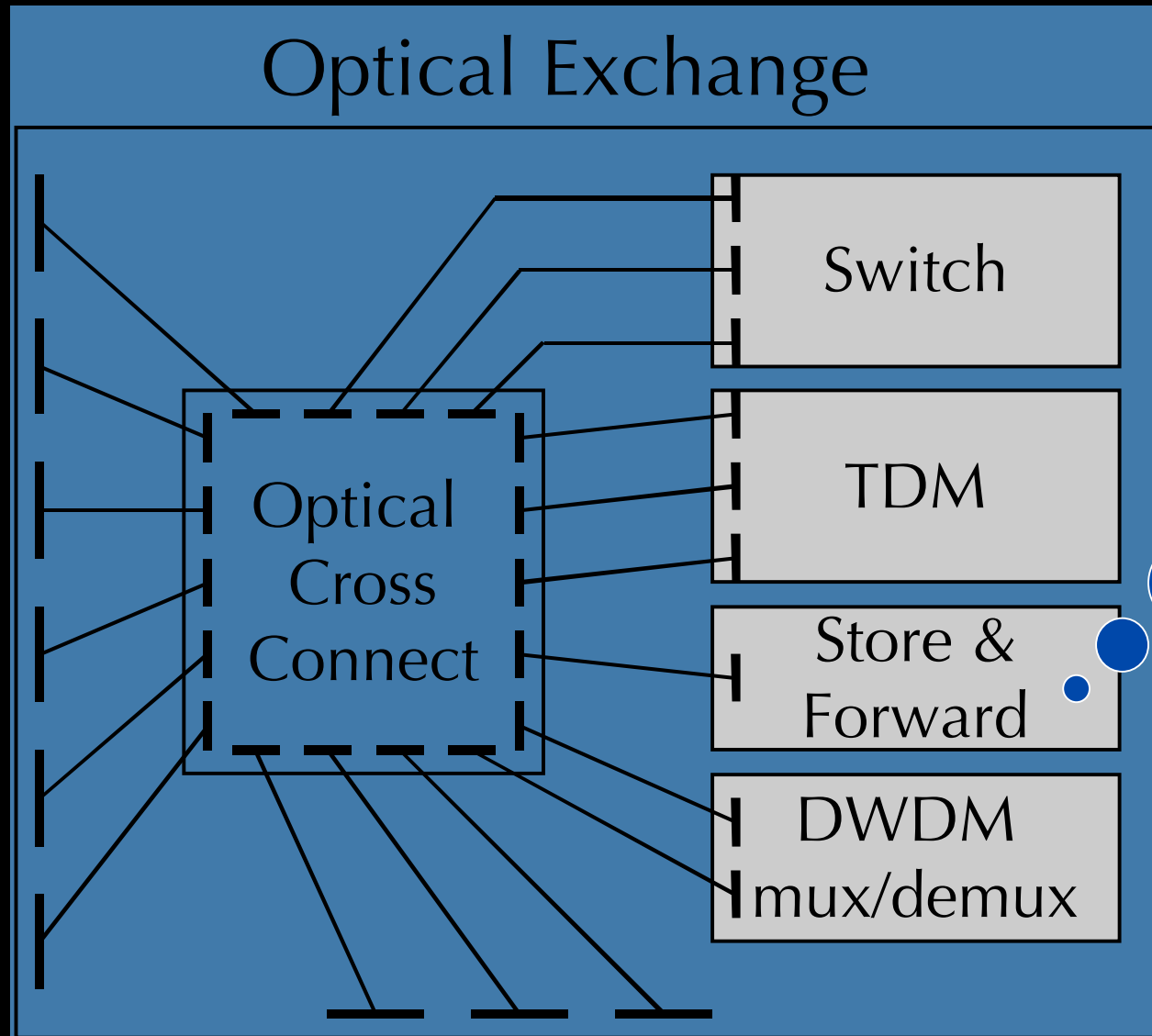




GLIF Q3 2005

•Visualization courtesy of Bob Patterson, NCSA  
•Data collection by Maxine Brown.

# Optical Exchange as Black Box



- TeraByte
- Email
- Service

# Service Matrix

<b>From</b>	<b>To</b>	<b>WDM (multiple <math>\lambda</math>)</b>	<b>Single <math>\lambda</math>, any bitstream</b>	<b>SONET/SDH</b>	<b>1 Gb/s Ethernet</b>	<b>LAN PHY Ethernet</b>	<b>WAN PHY Ethernet</b>	<b>VLAN tagged Ethernet</b>	<b>IP over Ethernet</b>
<b>WDM (multiple <math>\lambda</math>)</b>		cross-connect multicast, regenerate, multicast	WDM demux	WDM demux*	WDM demux *	WDM demux *	WDM demux *	WDM demux *	WDM demux *
<b>Single <math>\lambda</math>, any bitstream</b>		WDM mux	cross-connect multicast, regenerate, multicast	N/A *	N/A *	N/A *	N/A *	N/A *	N/A *
<b>SONET/SDH</b>		WDM mux	N/A *	SONET switch, +	TDM demux *	TDM demux <sup>6</sup>	SONET switch	TDM demux *	TDM demux *
<b>1 Gb/s Ethernet</b>		WDM mux	N/A *	TDM mux	aggregate, Ethernet conversion +	aggregate, eth. convert	aggregate, Ethernet conversion	aggregate, VLAN encap	L3 entry *
<b>LAN PHY Ethernet</b>		WDM mux	N/A*	TDM mux <sup>6</sup>	aggregate, Ethernet conversion	aggregate, Ethernet conversion +	Ethernet conversion	aggregate, VLAN encap	L3 entry *
<b>WAN PHY Ethernet</b>		WDM mux	N/A *	SONET switch	aggregate, Ethernet conversion	Ethernet conversion	aggregate, Ethernet conversion +	aggregate, VLAN encap	L3 entry *
<b>VLAN tagged Ethernet</b>		WDM mux	N/A *	TDM mux	aggregate, VLAN decap	aggregate, VLAN decap	aggregate, VLAN decap	Aggregate, VLAN decap & encap +	N/A
<b>IP over Ethernet</b>		WDM mux	N/A *	TDM mux	L3 exit *	L3 exit *	L3 exit *	N/A	Store & forward, L3 entry/exit+

# Amsterdam Internet Exchange

- Purpose

- To facilitate traffic exchange between Internet providers

- Implementation

- Basically a big Ethernet switch
  - All networks connect on layer 2
  - AMS-IX forwards traffic based on mac address only
  - Peering relations are managed by the connecting networks themselves
  - AMS-IX does not need to know, setup or agree for peering to happen!



# GOLE implementations

- Single switch implementation (SONET, L2)
- Combination of switches (SONET + L2)
- Extended (you connect anywhere and can peer with everyone else on the network)



# Packet versus circuit issues

- AMS-IX like internet exchanges do not need to know peering relations in order to forward traffic
- Those exchanges are not and do not need to be involved in decision taking about peerings
- In case of a GOLE the control plane of the infrastructure needs to know in order to set up the lightpath. Just having networks connected is not enough.
- In order to be an open neutral exchange the success of setup of circuits should depend on nothing more than technical issues (formats, capacity, etc.)





# GOLE: Two approaches

- Approach 1: GOLE is actively involved in user path request signaling and network routing.

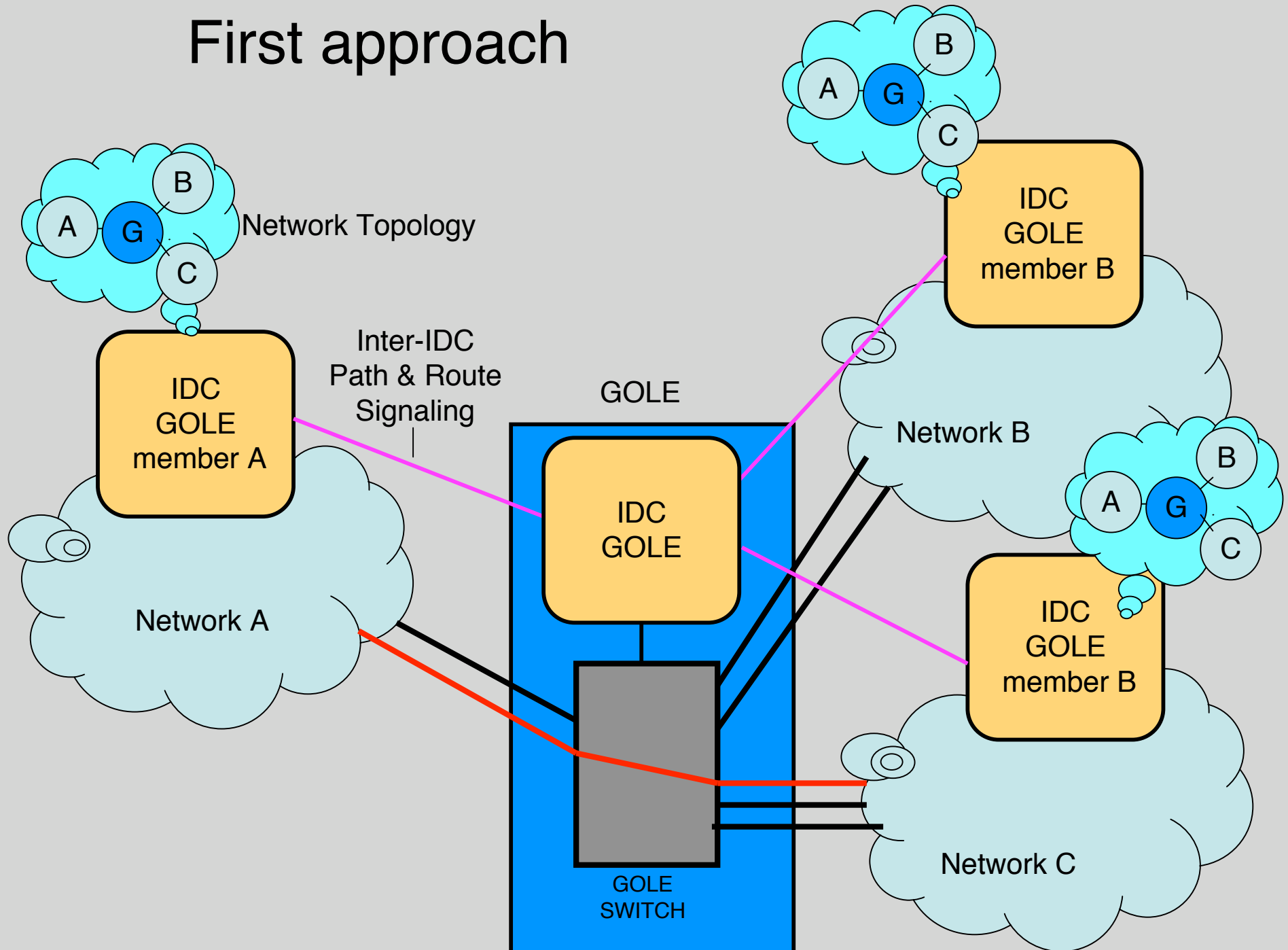
- GOLE is distinctly visible in the overall topology
- Participates in user request routing & signaling
- Acts as a regular network domain, but is expected to honor any request from a member. (may not refuse members connections)

- Approach 2: GOLE is only involved in provisioning a negotiated topology between GOLE members.

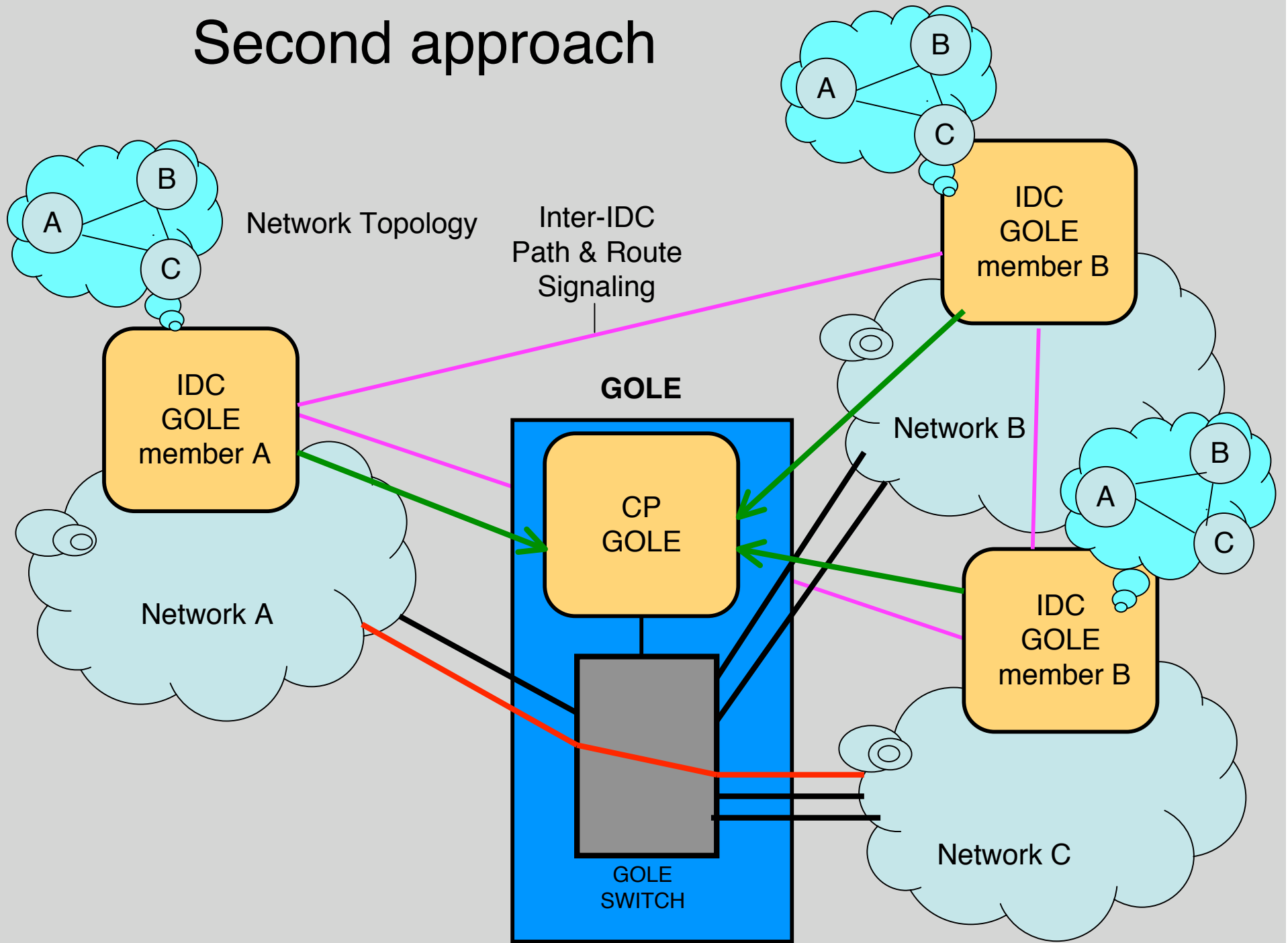
- GOLE is not distinctly visible in the overall topology
- Does not participate in user request signaling & routing
- Is only controlled by attached GOLE members via GOLE CP.
- Effects of the GOLE control may affect routing tables of member IDCs



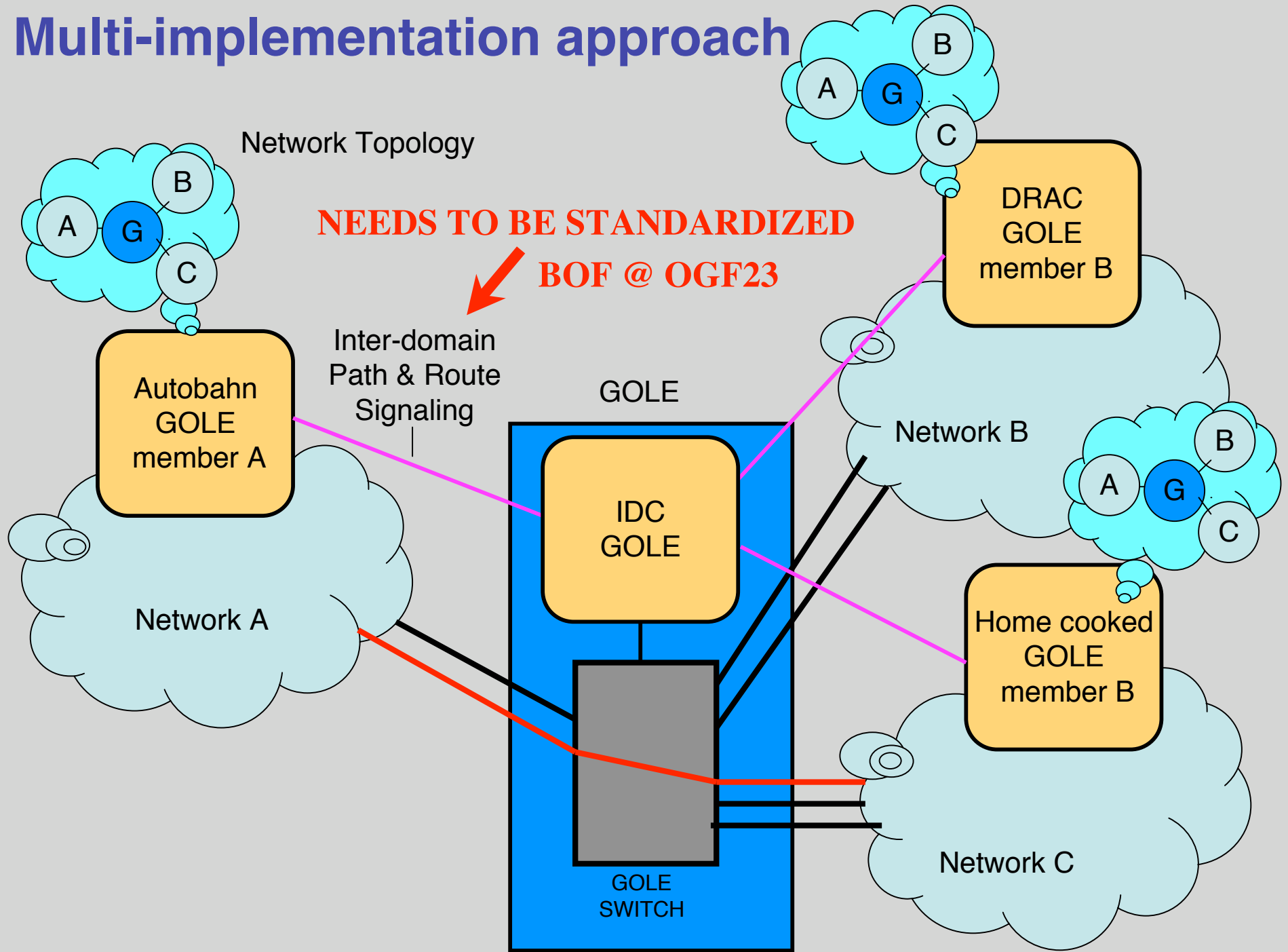
# First approach



# Second approach



# Multi-implementation approach



# Questions ?

See also:

- Freek Dijkstra, Cees de Laat, "Optical Exchanges", GRIDNETS conference proceedings, oct 2004
  - <http://www.broadnets.org/2004/workshop-papers/Gridnets/DijkstraF.pdf>
- Freek Dijkstra, Bas van Oudenaarde, Bert Andree, Leon Gommans, Paola Grosso, Jeroen van der Ham, Karst Koymans and Cees de Laat, "A Terminology for Control Models at Optical Exchanges", LCNS, Volume 4543, july 2007, Page 49-60