Samba KCC: Saying No to Full Mesh Replication

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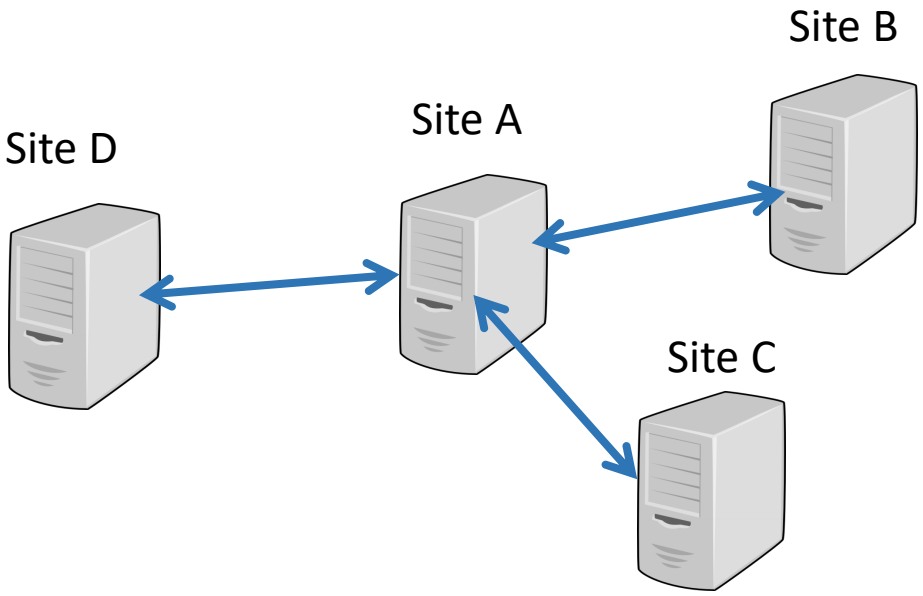
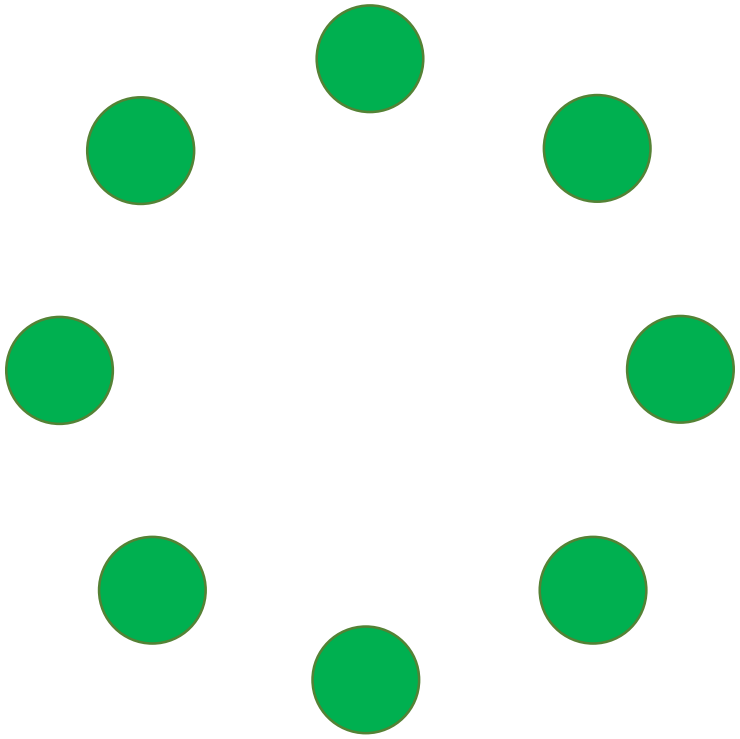
What is the KCC?

- Knowledge consistency checker
- Used to manage replication connections in AD
- Set of algorithms to produce efficient network topologies



What is the KCC?



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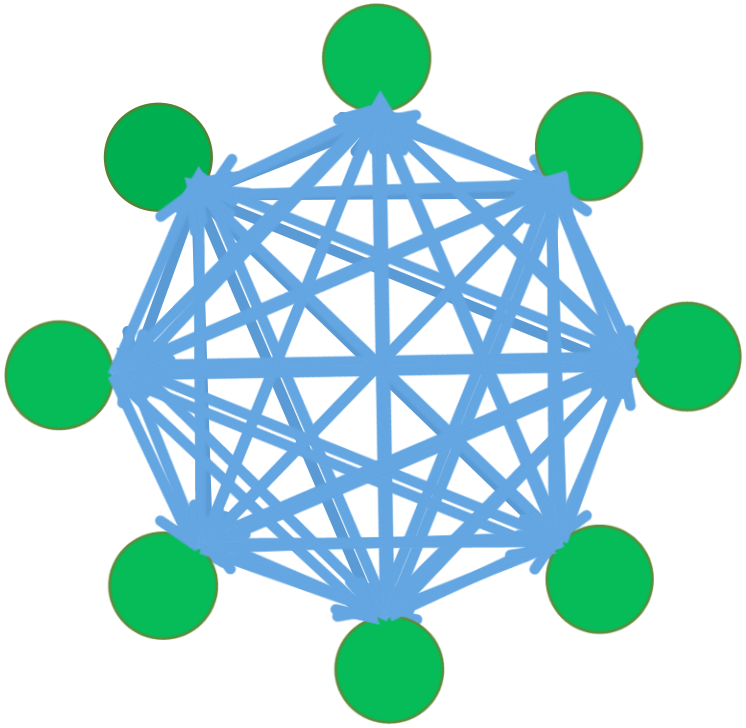

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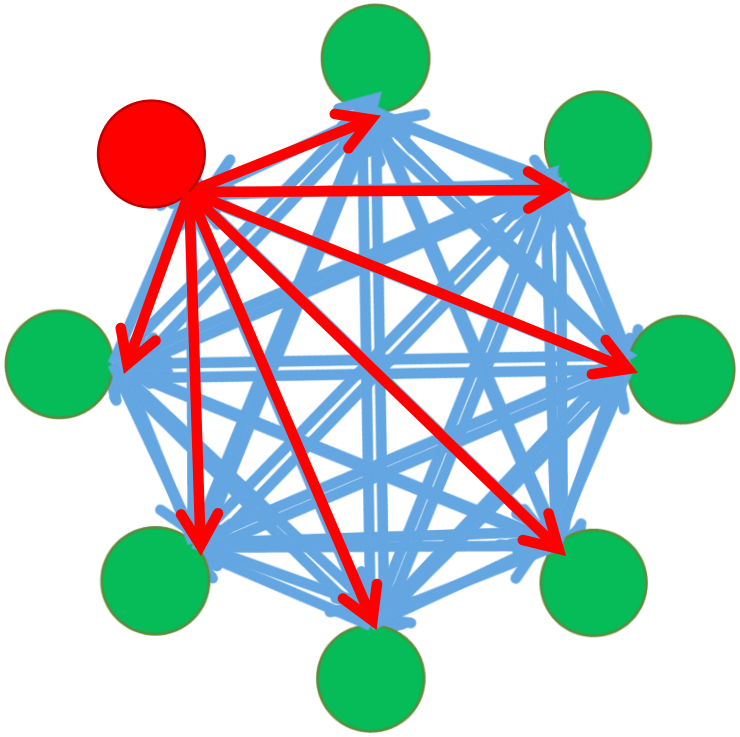

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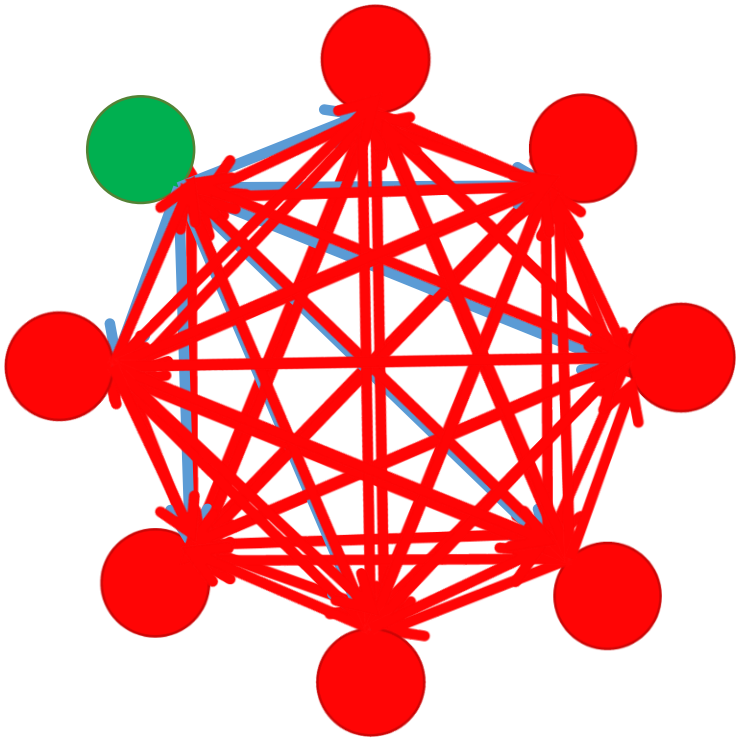


History of the KCC

- Original full-mesh C code
- Attempt at MS-ADTS algorithms in C
- Dave Craft (2011) on Python intra-site algorithms
- Late 2014—Early 2015 Douglas and myself
- Samba 4.3 introduced, Samba 4.5 set as default

Stages of the algorithm

- Intra-site algorithm
- Inter-site algorithm
- Removing unneeded connections
- Translate connections

Although the KCC creates ‘connection’ objects, they may not represent the underlying replication. They are only the implied connections given the current network topology.

Pre-requisites

- Transport – IP

```
dn: CN=IP,CN=Inter-Site Transports,CN=Sites,CN=Configuration,DC=example,DC=com
objectClass: interSiteTransport
```

- Sites – Default-First-Site

```
dn: CN=Default-First-Site-Name,CN=Sites,CN=Configuration,DC=example,DC=com
objectClass: site
```

```
dn: CN=NTDS Site Settings,CN=Default-First-Site-
Name,CN=Sites,CN=Configuration,DC=example,DC=com
objectClass: nTDSSiteSettings
interSiteTopologyGenerator: CN=NTDS Settings,CN=DC,CN=Servers,CN=Default-First-Site-
Name,CN=Sites,CN=Configuration,DC=example,DC=com
```

Pre-requisites

- Site-Links – DEFAULTIPSITELINK

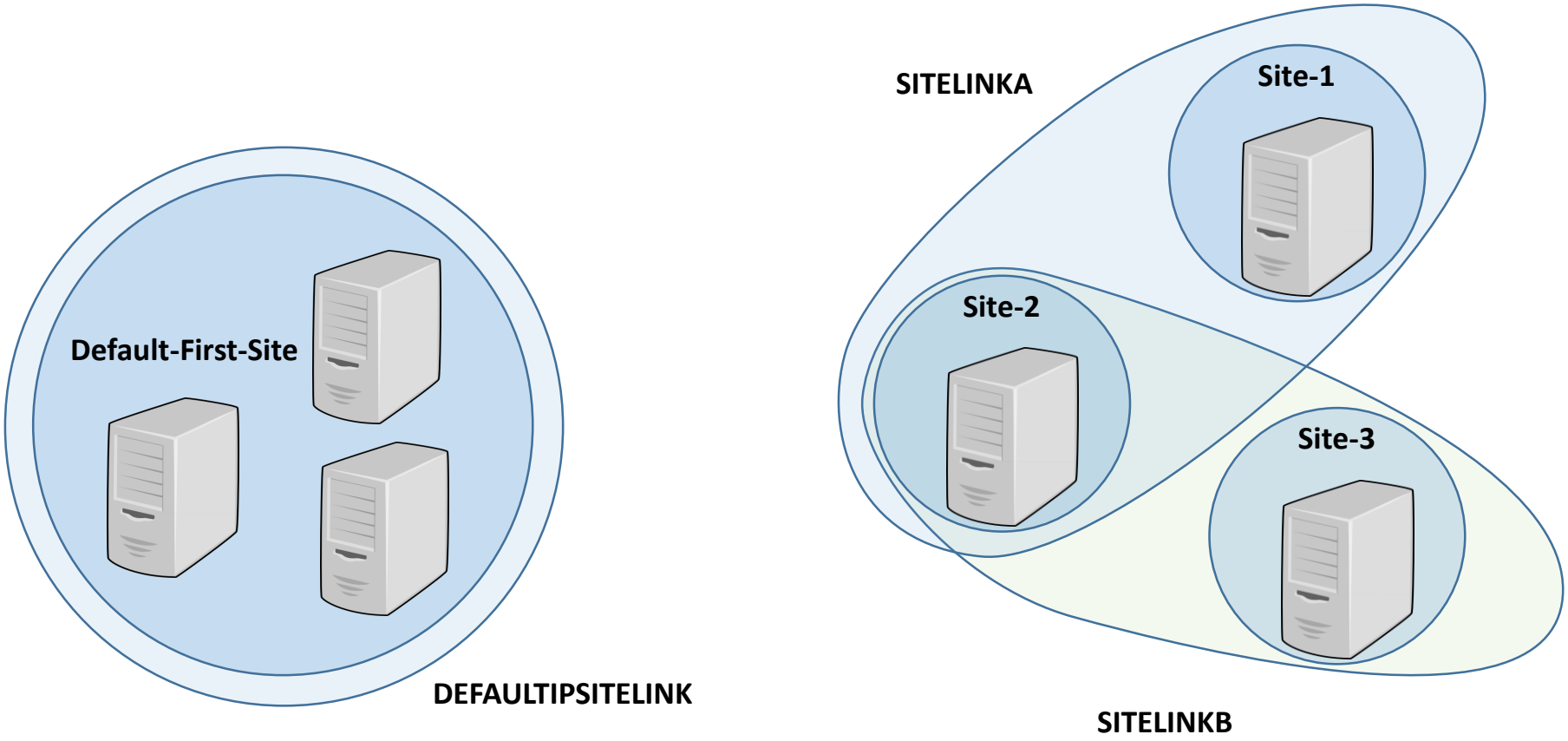
```
dn: CN=DEFAULTIPSITELINK,CN=IP,CN=Inter-Site
Transports,CN=Sites,CN=Configuration,DC=example,DC=com
objectClass: siteLink
cost: 100
siteList: CN=Default-First-Site-Name,CN=Sites,CN=Configuration,DC=example,DC=com
```

Site-links define the allowable connections between sites

Site-links represent (hub-like) physical connectivity

Site-links needs to collectively span your entire network

Pre-requisites - Scenarios

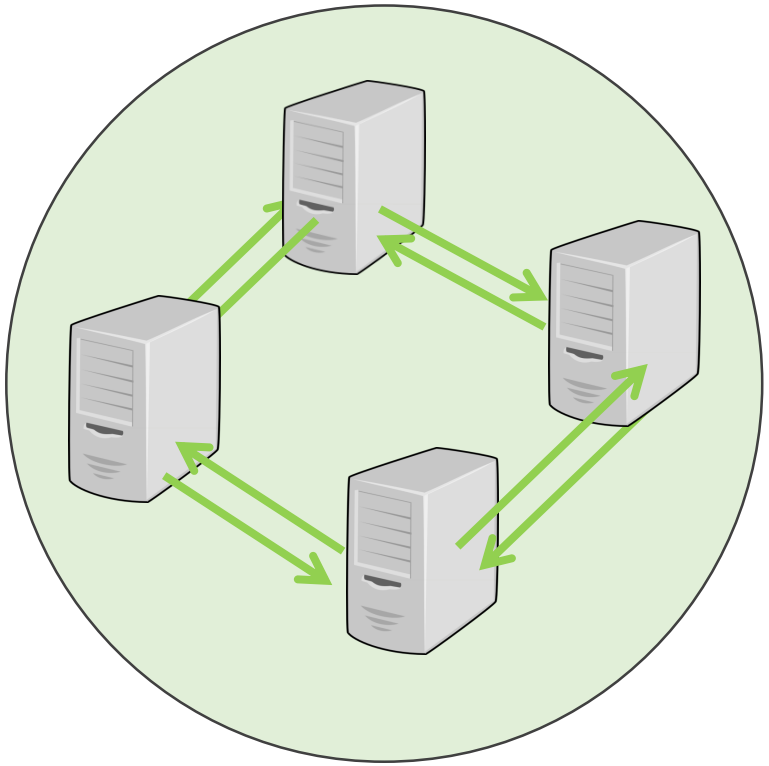


Intra-site algorithm

- Runs on every DC
- Creates connections within a single site
- With just a single server, no work is necessary
- Ring topology, with a few extra connections (n > 7)

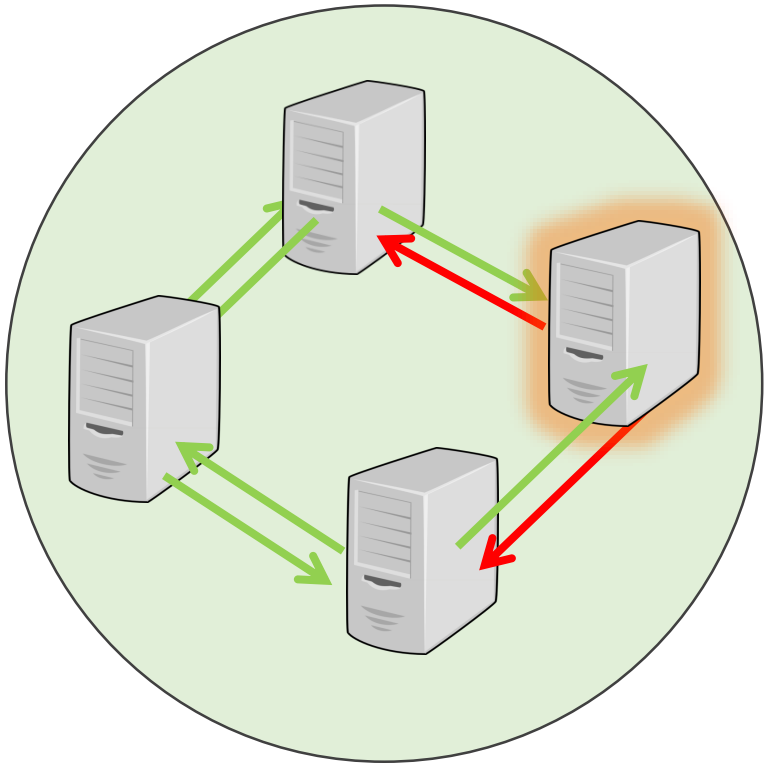
Intra-site algorithm

- Ring topology, with a few extra connections



Intra-site algorithm

- Every DC in the site has a sorted list of site DCs



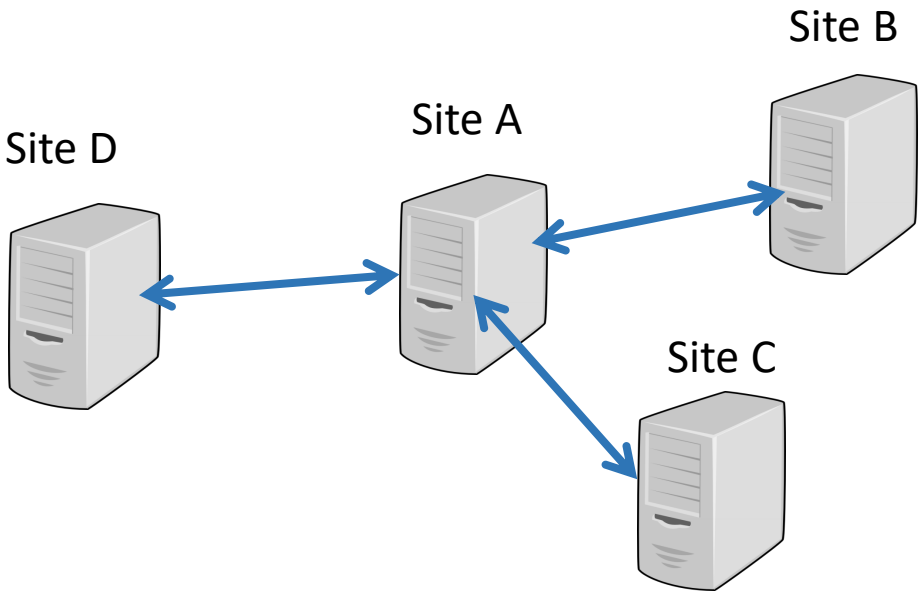
Intra-site algorithm

- Compared to the old KCC, there are fewer connections
- The algorithm is quite reliable, adding additional connections
- Information propagates in a more controlled manner

In a single-site use-case, with not that many DCs, behaviour should be quite similar to the old code.

Inter-site algorithm

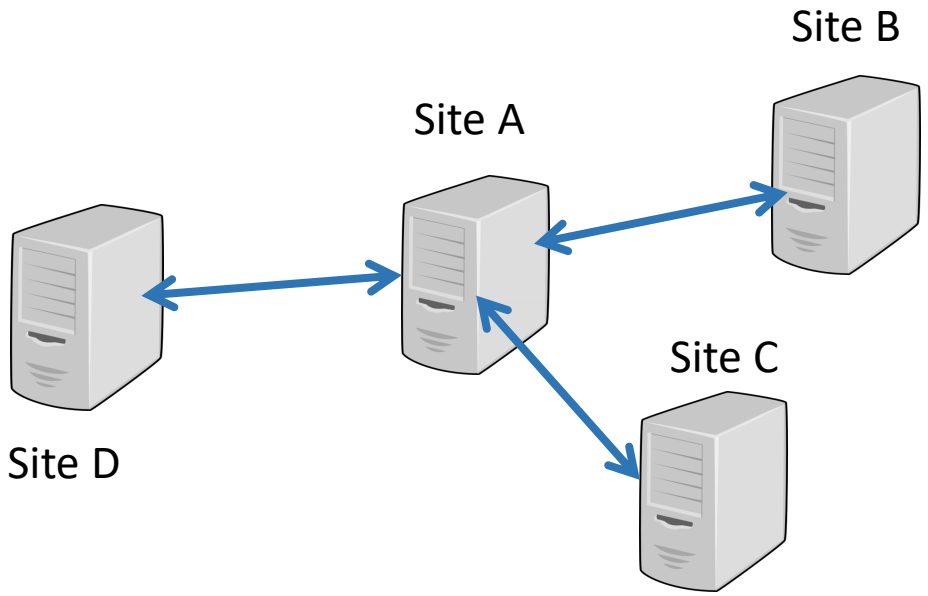
- Each site elects an inter-site topology generator (ISTG)
- Re-election attempts to occur if the ISTG is not responding
- Attribute: interSiteTopologyFailover



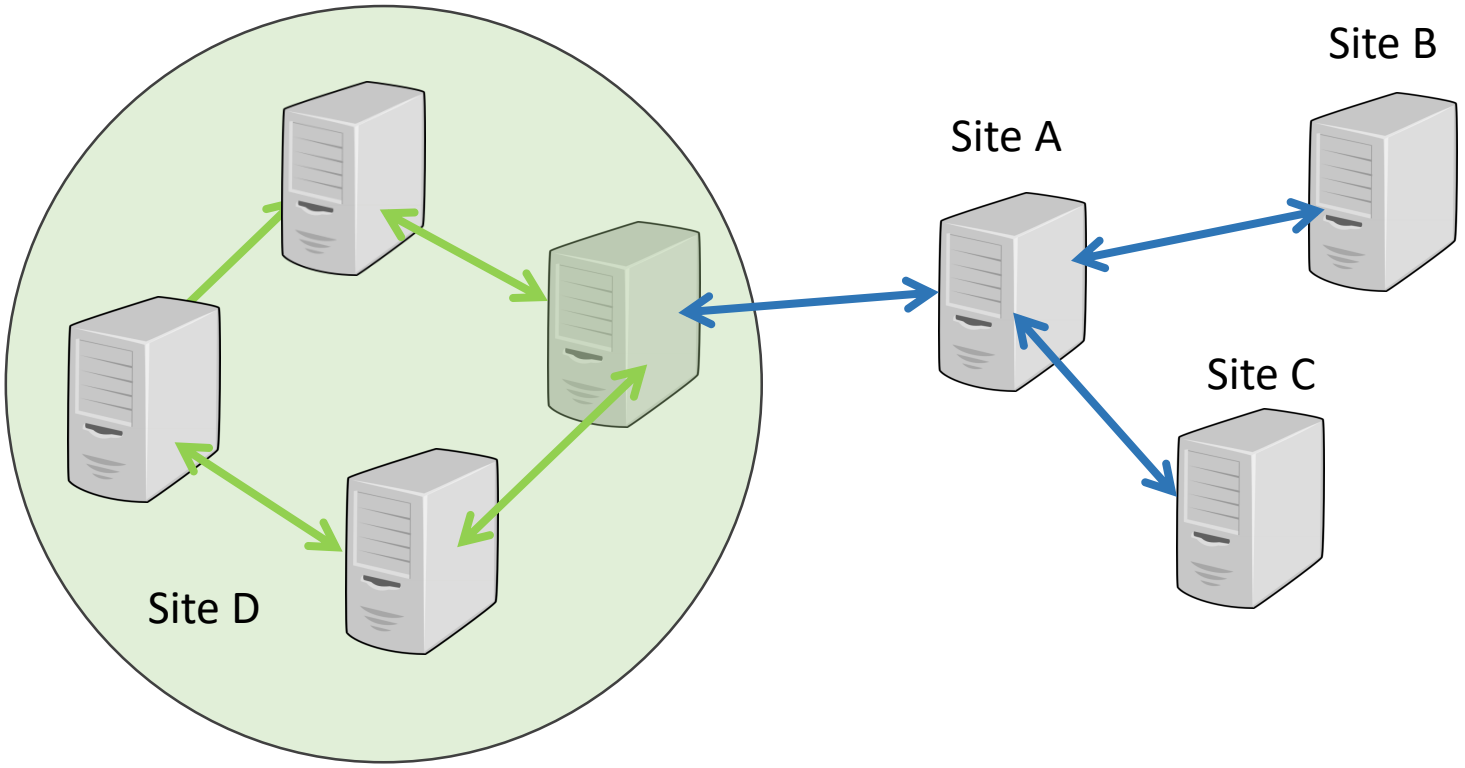
Inter-site algorithm

- Stable answer across entire DC network
- One DC per site managing inter-site connections
- Needs to be as fault tolerant as possible
- Must produce topology optimizing cost and schedules

Inter-site algorithm

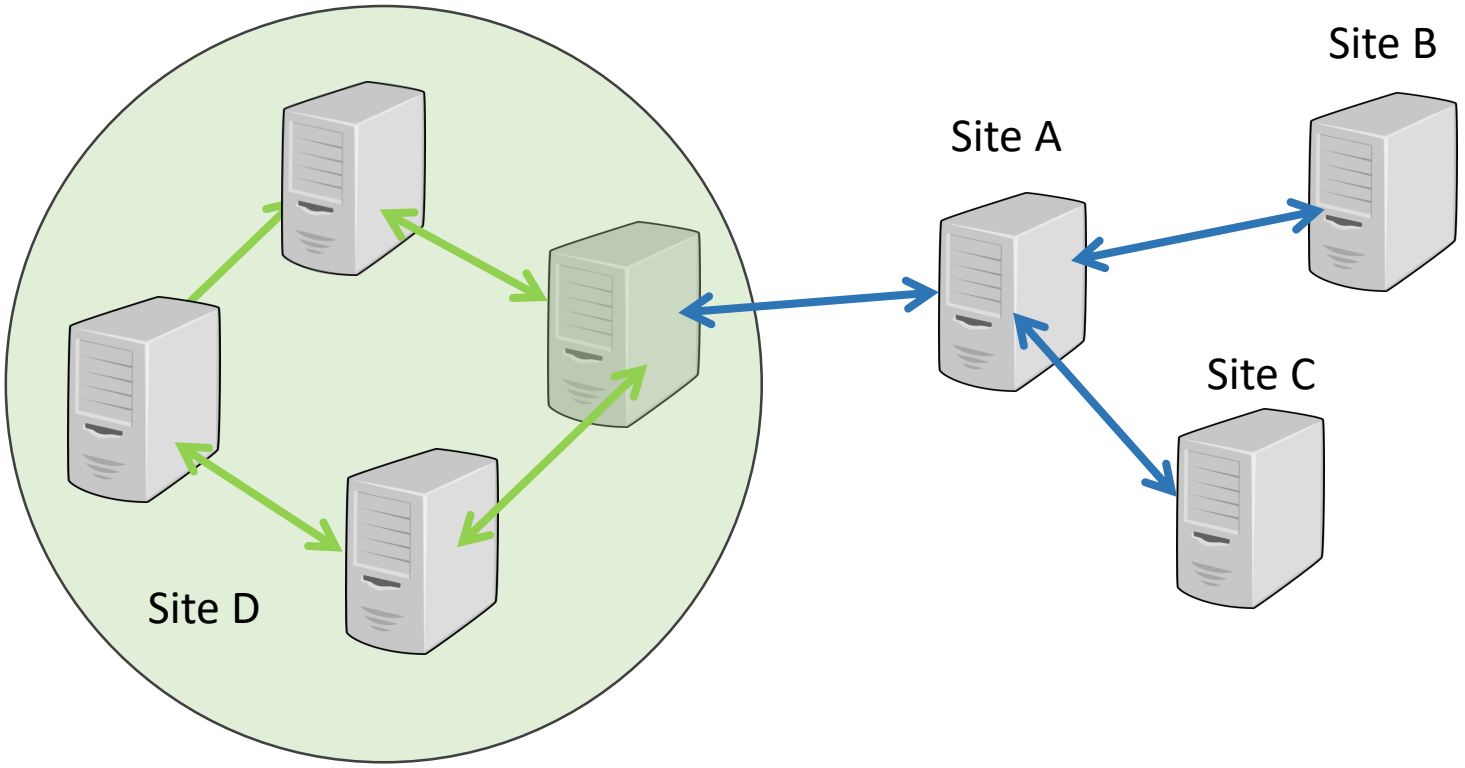


Inter-site algorithm



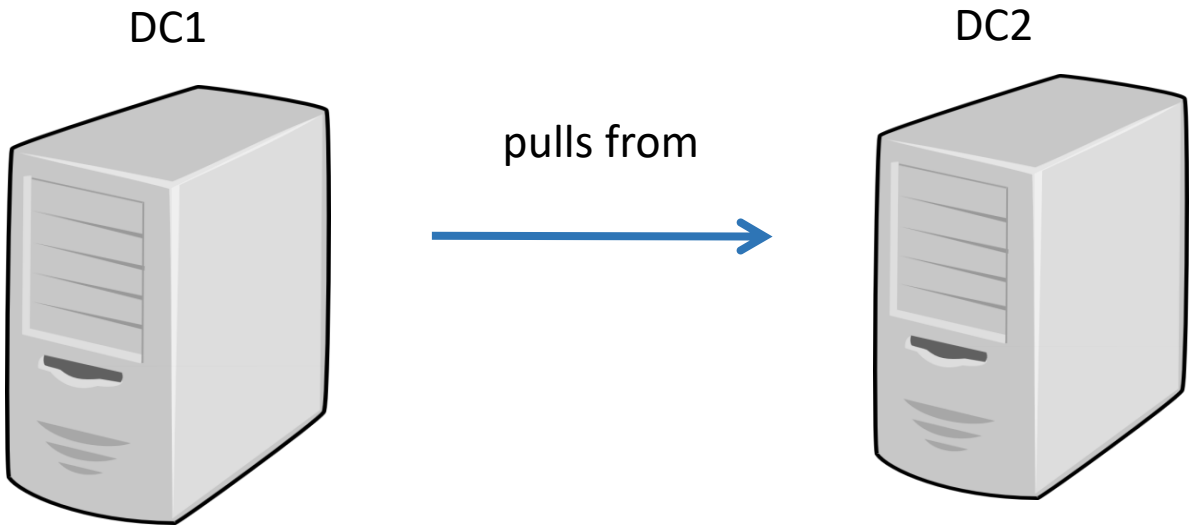
Bridgehead servers are the end-point connections between sites.

Inter-site algorithm



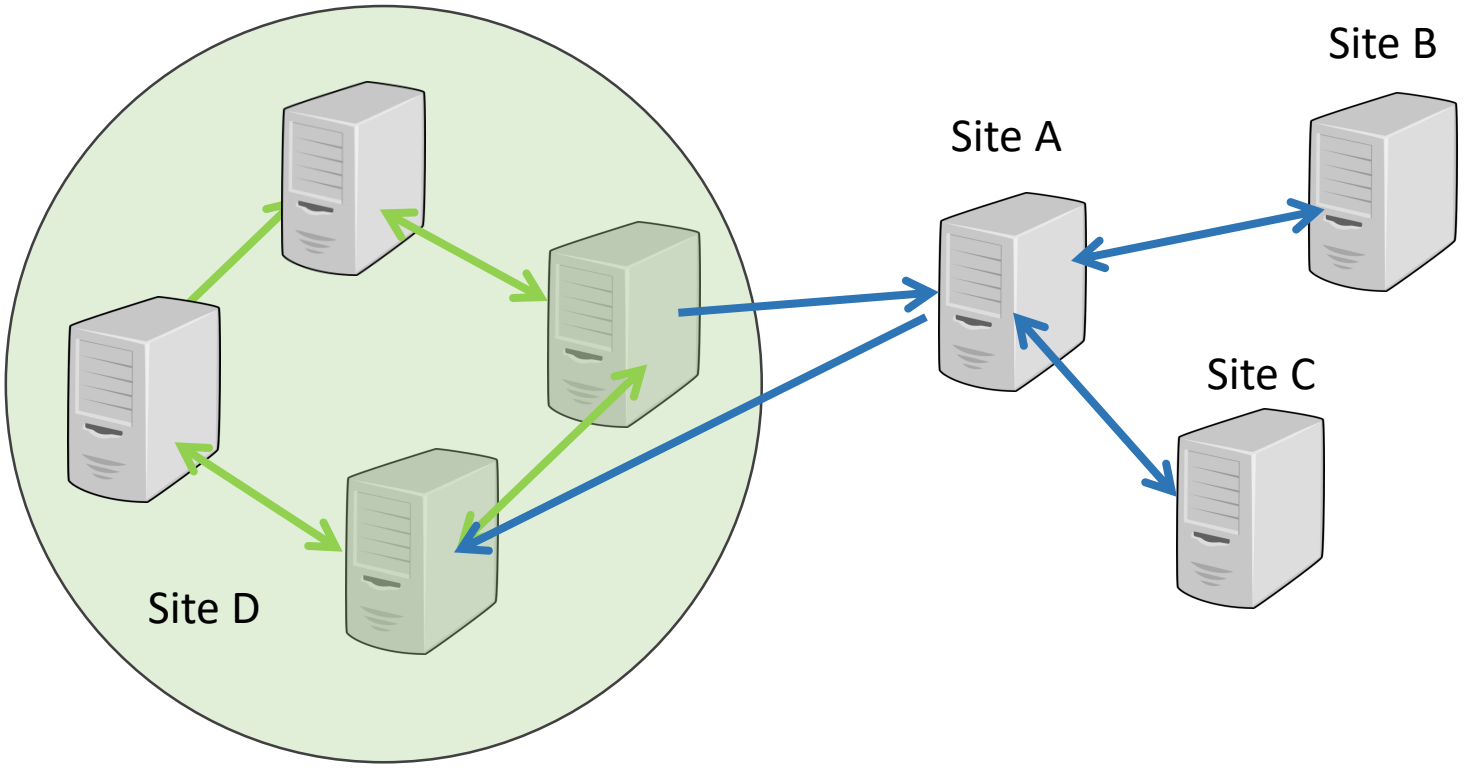
Being a bridgehead does not imply being an ISTG.

Inter-site algorithm



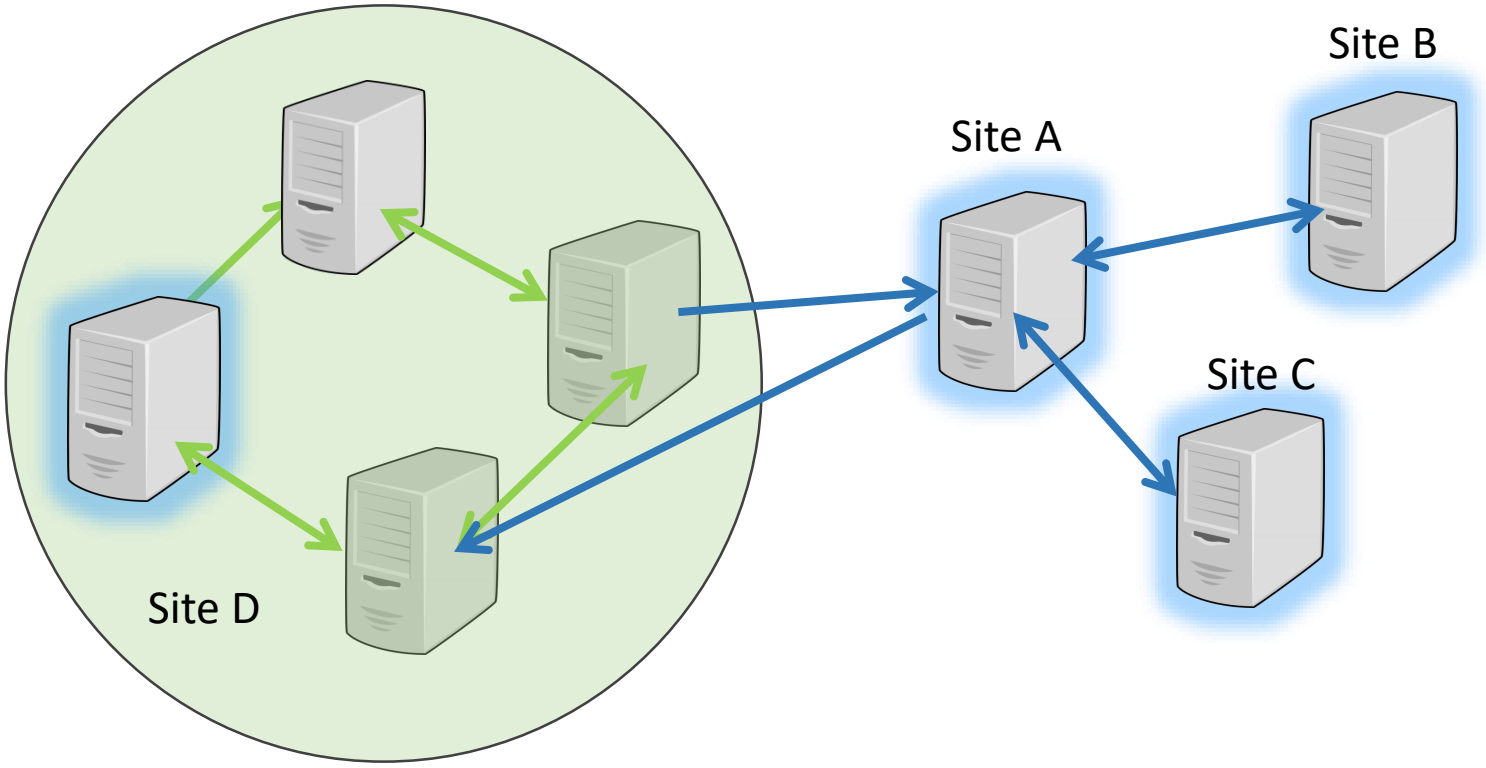
There is only pull replication.
Bi-directional replication must be done with two distinct connections.

Inter-site algorithm



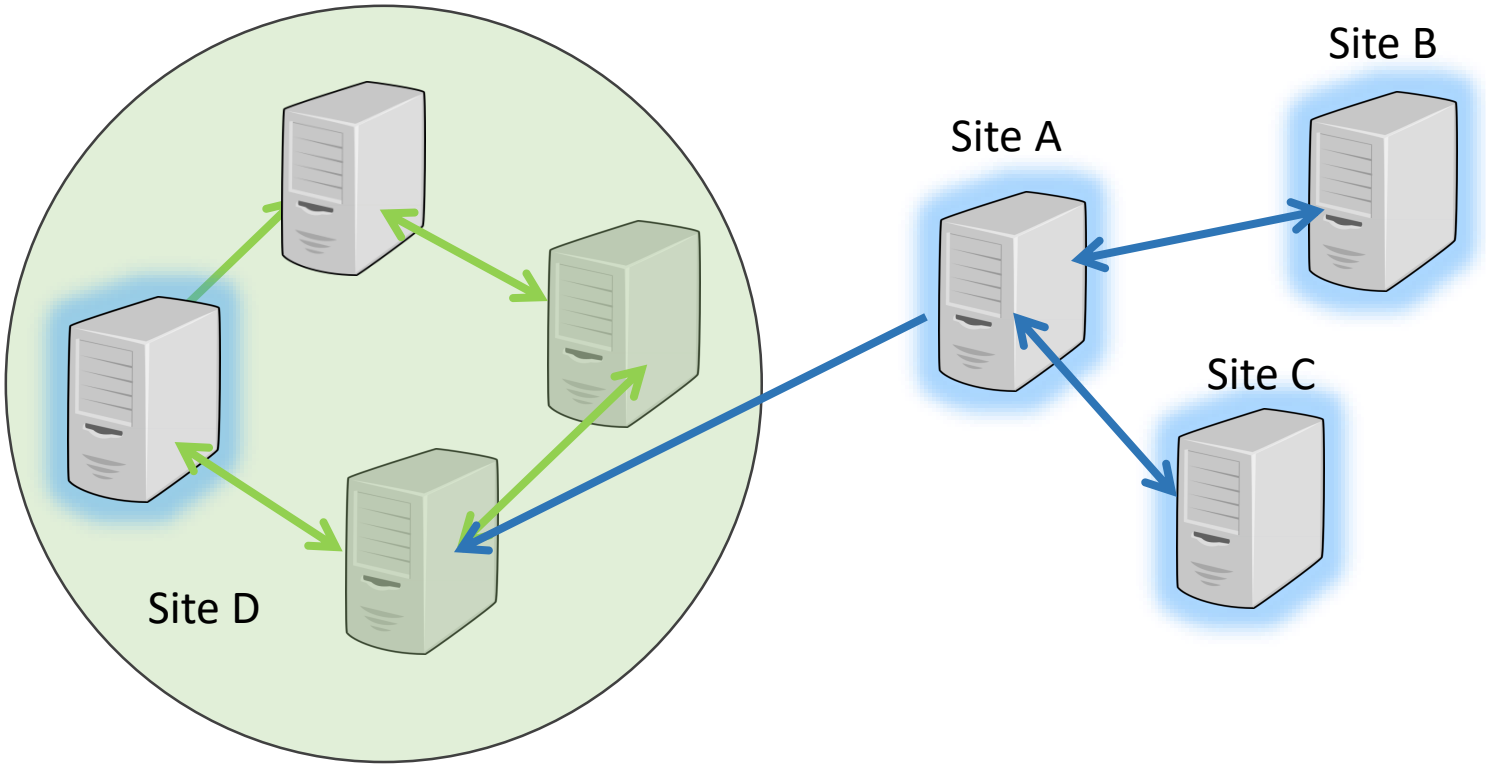
There is not necessarily a single bridgehead server.

Inter-site algorithm



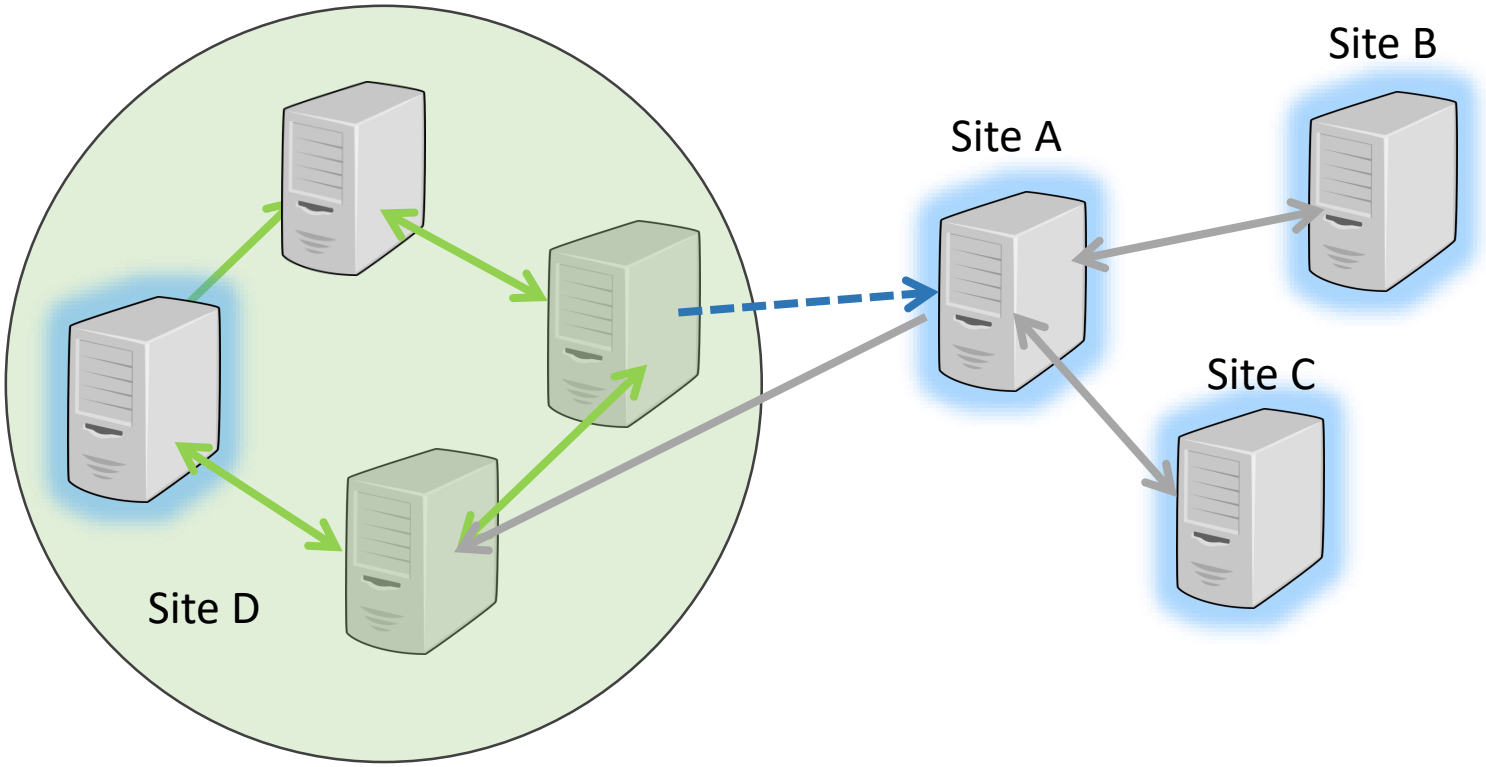
The inter-site algorithm only runs on the ISTG.

Inter-site algorithm



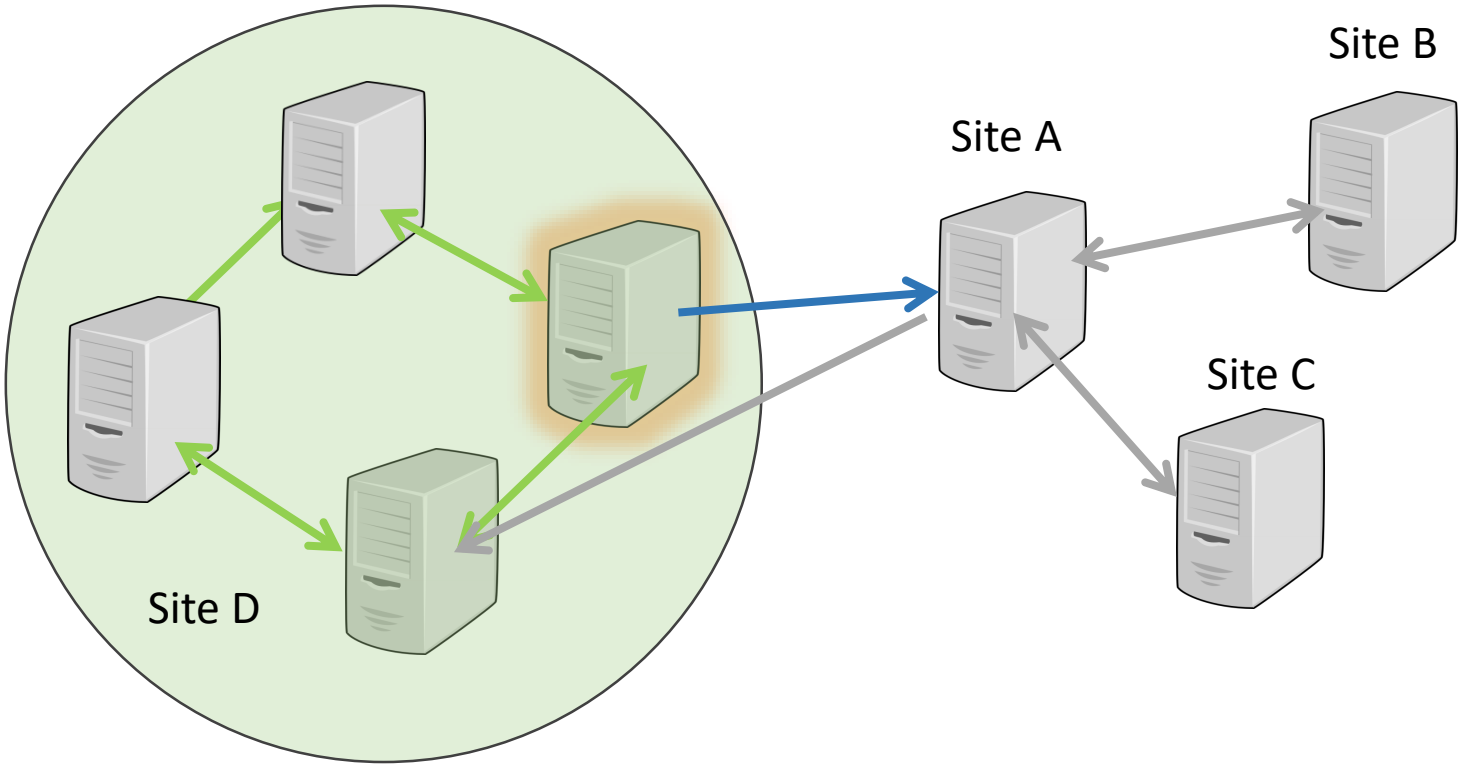
Assume the ISTG in Site D is running for the first time.

Inter-site algorithm



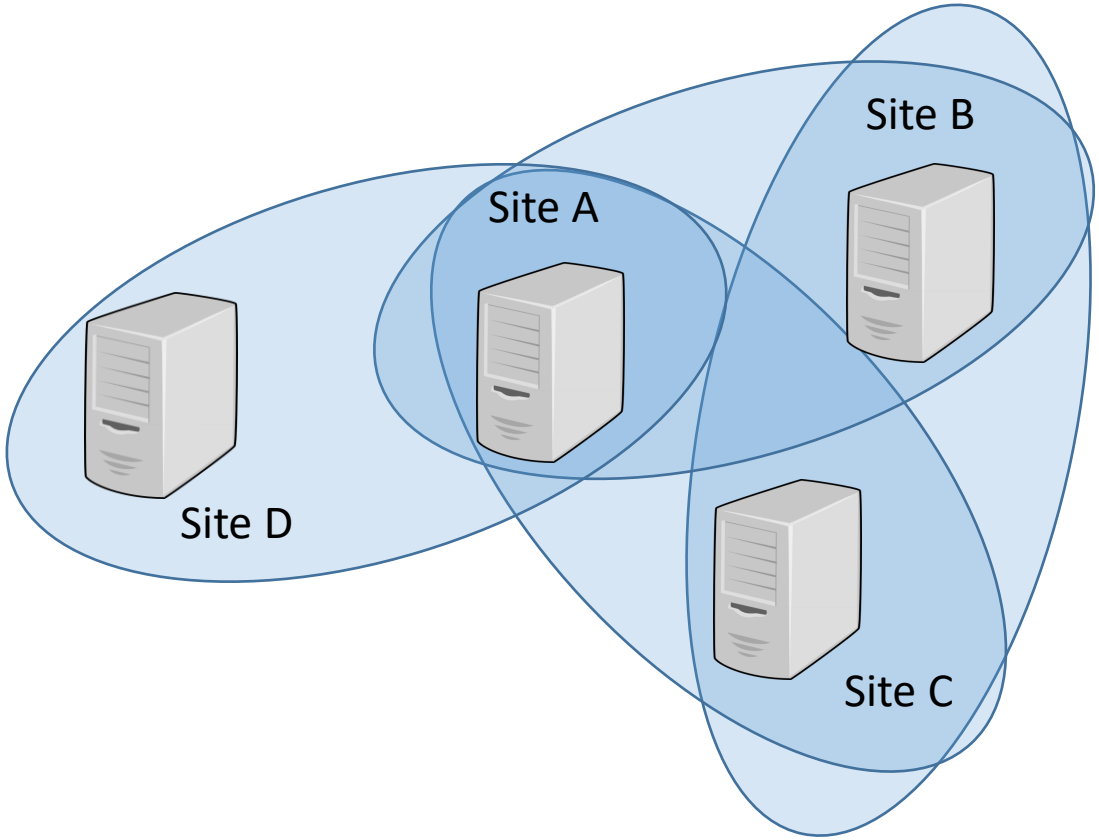
A new connection will be created in the database pointing to a randomly chosen bridgehead in Site A. Intra-site replication will propagate this to the necessary bridgehead in Site D.

Inter-site algorithm



The incoming bridgehead runs the KCC and notices the new connection (and translates it). It has no idea why it connects to the DC, that's the role of the ISTG.

Inter-site algorithm



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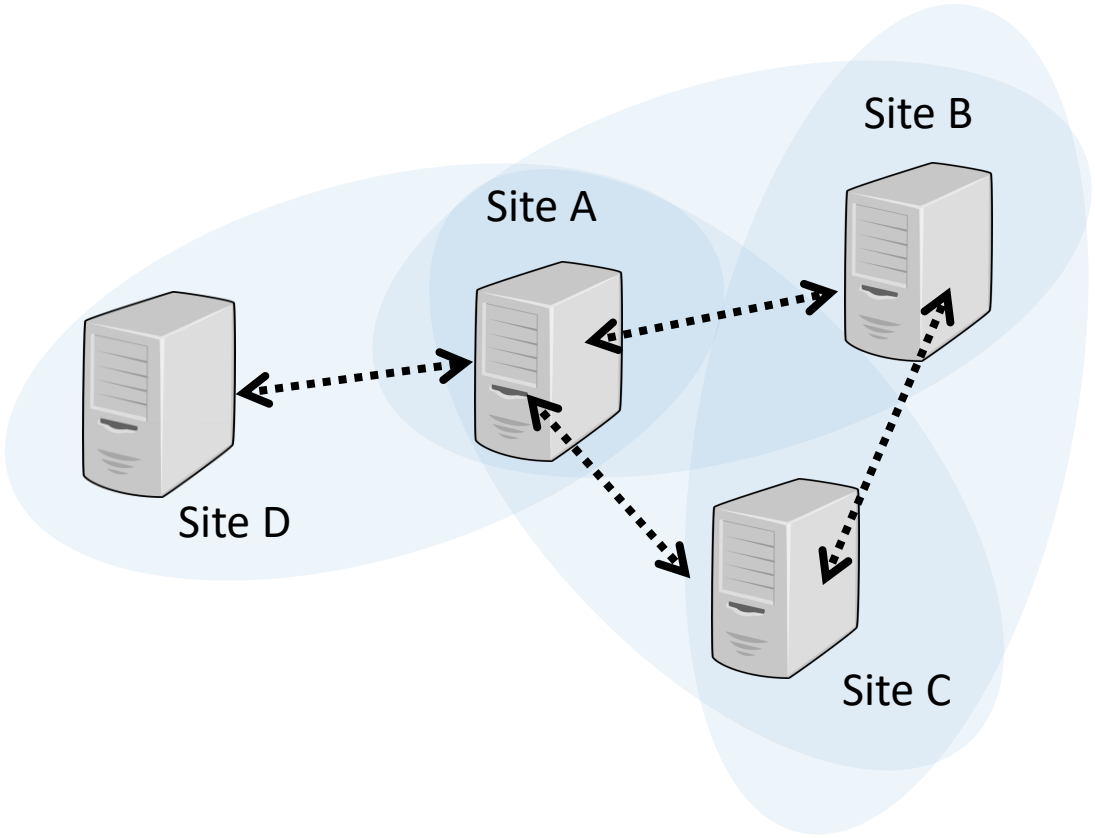
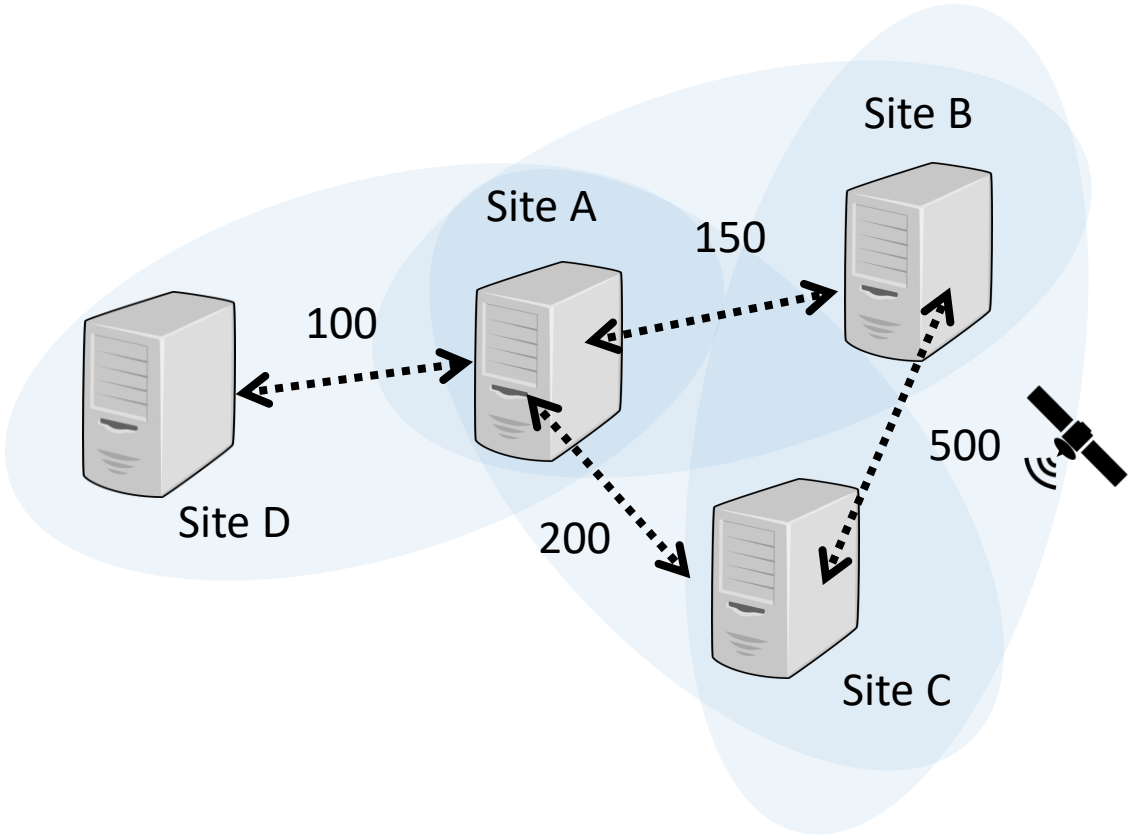


Inter-site algorithm



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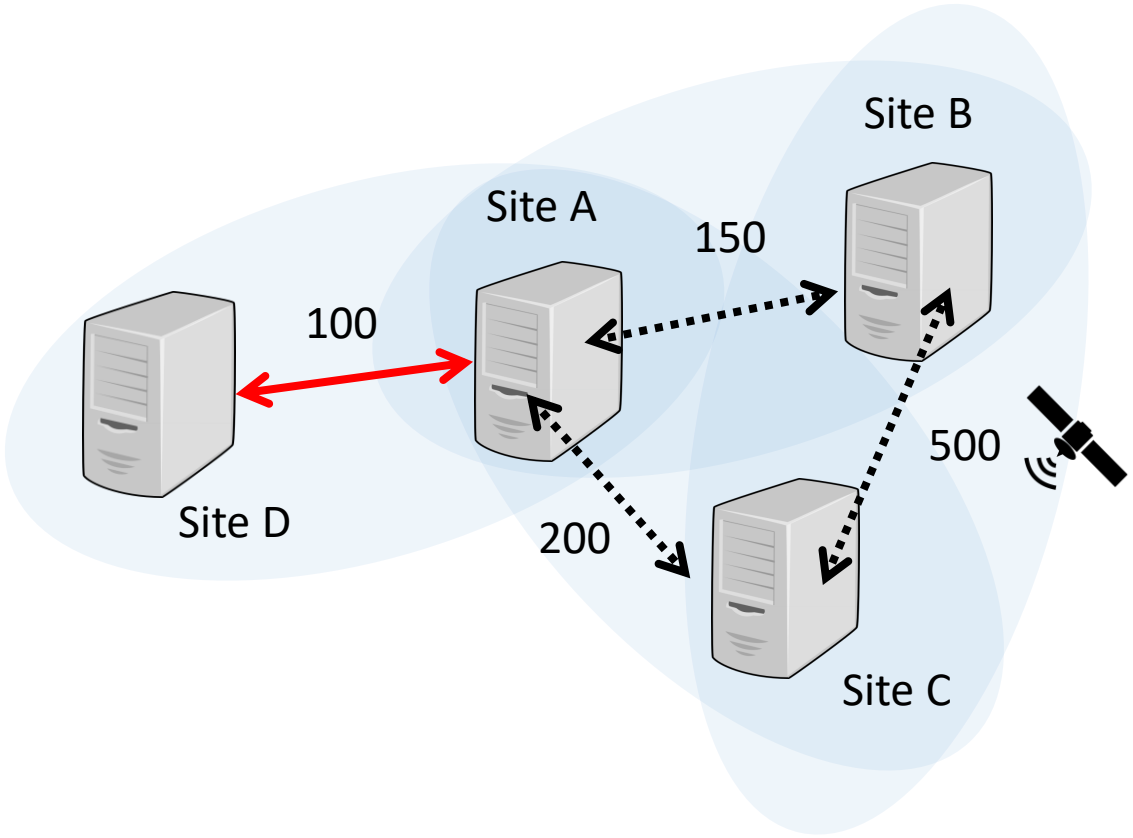
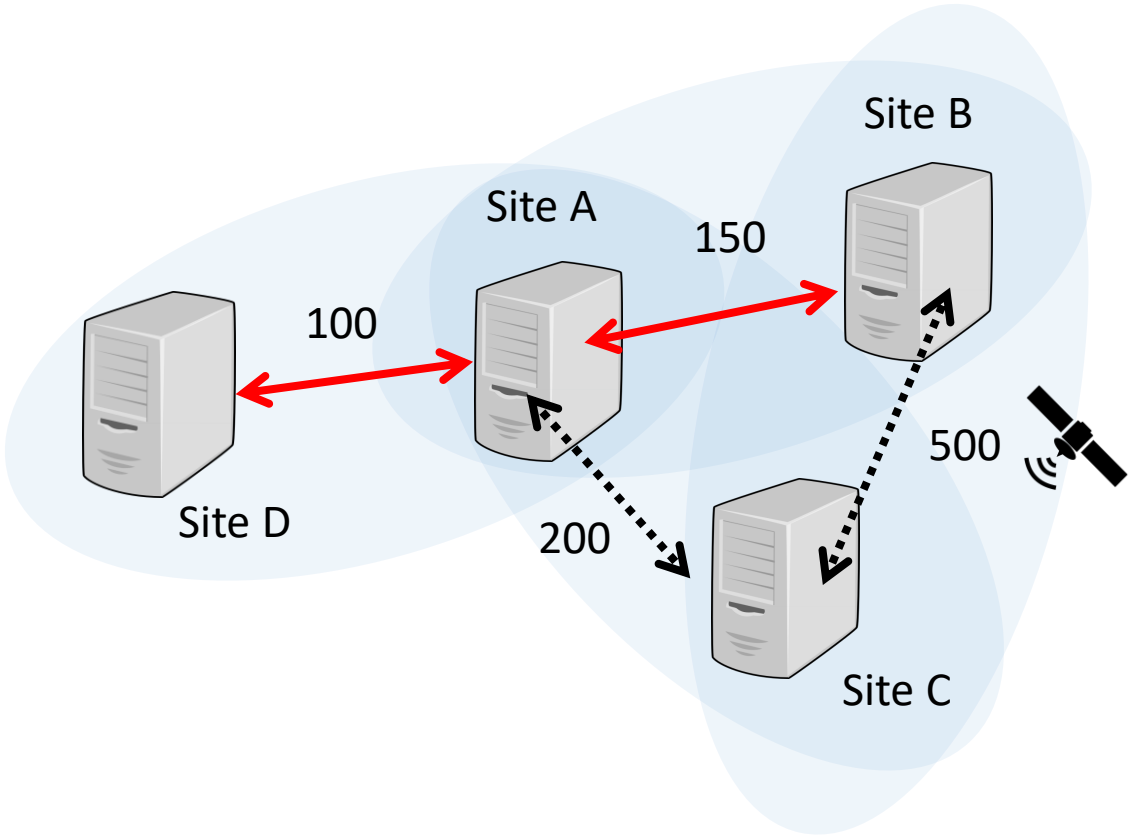
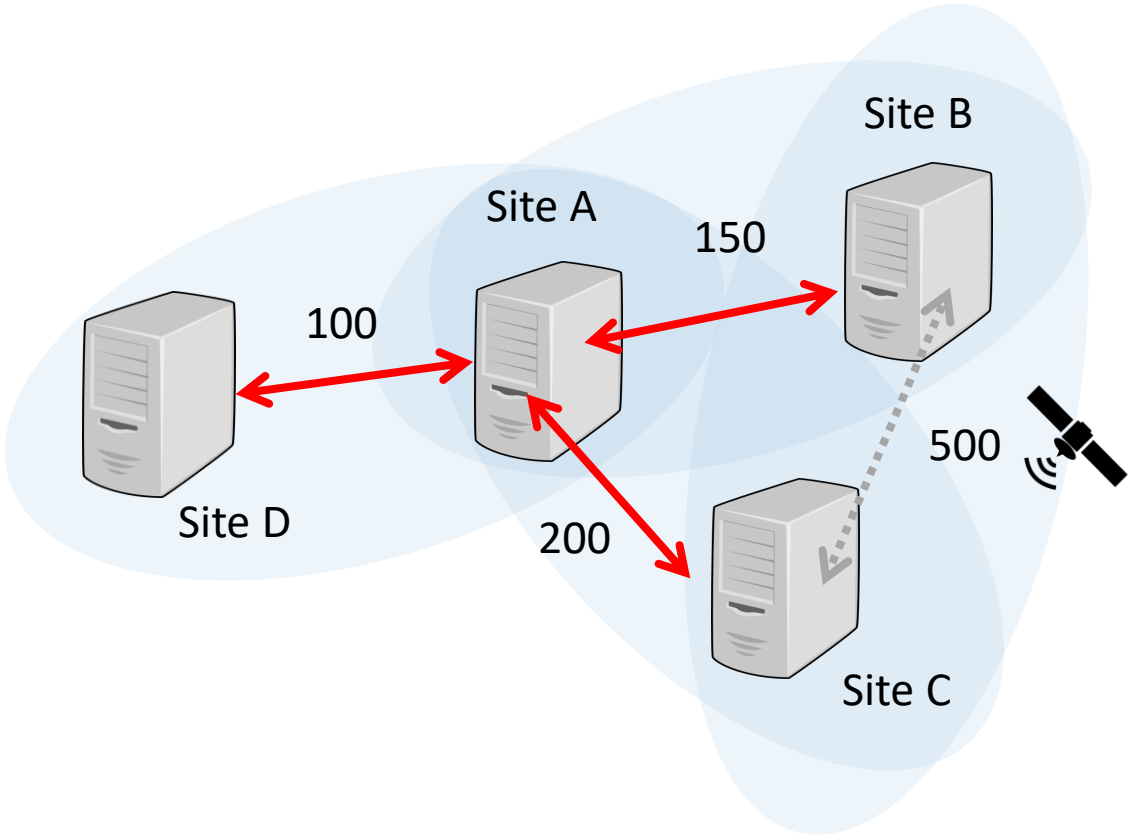


Add connection to the list of required ones.

Inter-site algorithm

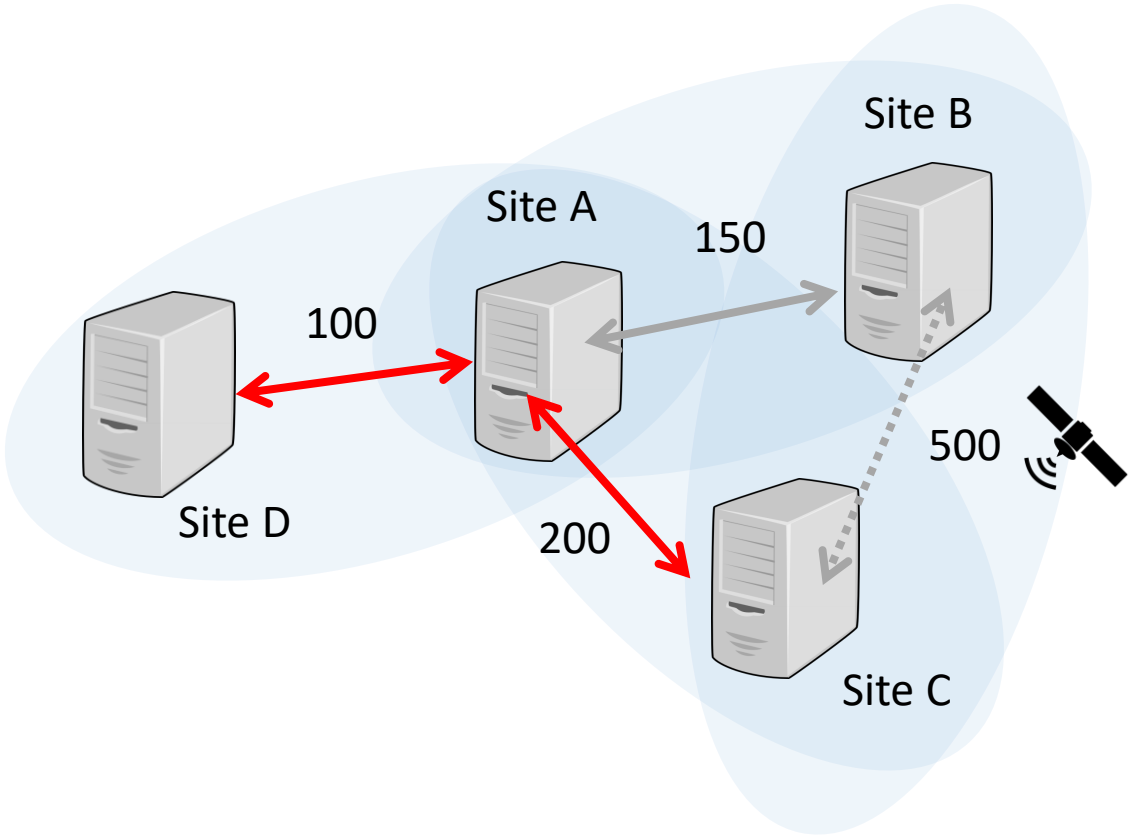


Inter-site algorithm

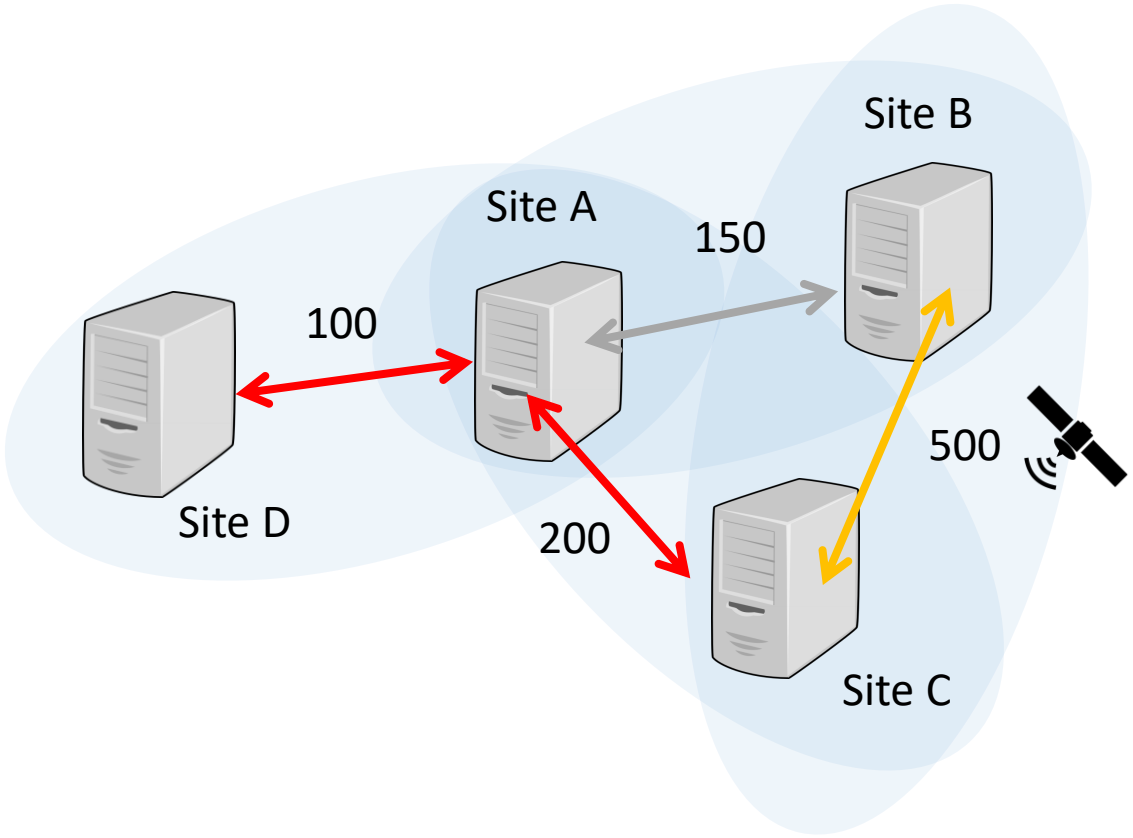


Total cost: 450

Inter-site algorithm - Failover



Inter-site algorithm - Failover



On network connectivity failure, the KCC attempts to overlay a second redundant topology. For small networks with multiple sites, you may favour the robustness of the old KCC.

Remove unneeded connections

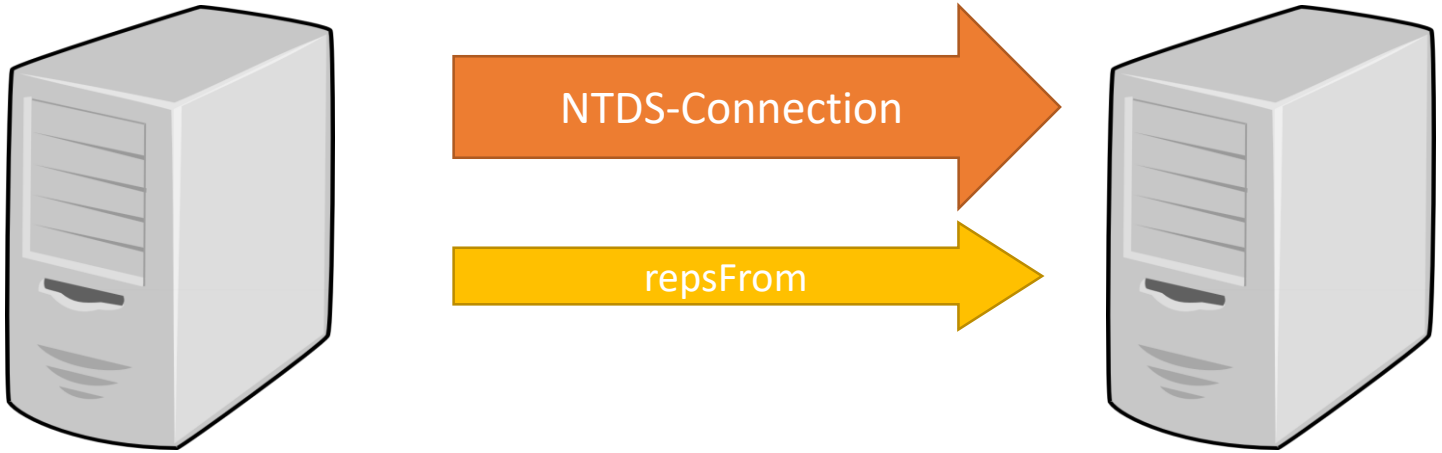
Removes connections:

- which are duplicated (removing the oldest)
- which exceed redundancy limit (intra-site)

Area still needs some work, however, removing too aggressively may cause connectivity issues.

Translate connections

- Of the connections the KCC deems necessary, they are translated into repsFrom (non-replicated attributes)



Two independent tasks running

- KCC running periodically
    - Creating NTDS Connection objects (ISTG or intra-site)
    - Translating NTDS Connections to repsFrom

- DREPL server
    - Reading repsFrom and pulling from the target
    - Reading repsTo and telling target to pull

This means it can take some time to propagate, particularly repsTo which are deferred created by replication on repsFrom.

Translate connections

- Of the connections the KCC deems necessary, they are translated into repsFrom (non-replicated attributes)

- repsFrom flags are set (particularly important for RODC)
- Stale repsFrom SHOULD be deleted
- Stale repsTo SHOULD be deleted

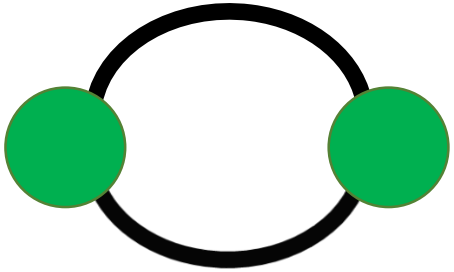
The end result

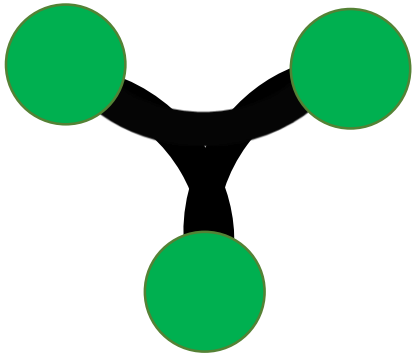
- Single path from any site to any site (property of a tree)
- Changes should not bounce around significantly
- Significantly reduced replication traffic
- Ability to customize who should talk to who

- Small networks (n <= 4) should have no visible effect
- Larger networks with varying connectivity shows huge effect

Challenges

- Verbose documentation
- Site-Link: ‘Multi-edge’, hyper-edge?
- White, red, black vertices?





More challenges

- Logical inconsistencies, ambiguities and omissions
- Pseudo-code vs textual description
- Easy to debug your own bugs
    - Testing?
    - --dot-file-dir
    - --readonly --exportldif, --importldif

Incomplete features

- Trusted domains and global catalog replication
- RODC self-management
- Site-Link-Bridge Topologies
- Respecting schedules and other AD attributes
    - Preferred bridgehead servers
    - Replication frequency?

Incomplete features

- Failed connection and failed DC failover
- Better stale connection clean-up
    - MS-DS-Replicates-NC-Reason
    - Use normal replication to propagate failure info
- Better debugging and failure information
- Better defaults for modern networks

Alternative topology strategies

- What is the best topology for various networks?

- Ring algorithm from intra-site for inter-site
- Minimum cost spanning tree plus additional connections
- Fully connected bridge-head servers

Questions?

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