OSPF

Area Types

Recall that a large OSPF domain is typically broken into separate areas to restrict the propagation of routes and reduce the amount of resources required by each router to maintain its link state database. Each area is connected to a central backbone, area zero.

OSPF relies on several types of *Link State Advertisements (LSAs)* to communicate link state information between neighbors. A brief review of the most applicable LSA types:

- LSA Type 1 – Router Link Advertisements – All OSPF devices send this LSA type, it contains the states of all of the interfaces that the device has in the OSPF domain. This LSA type is kept within a single area.
- LSA Type 2 – Network Link Advertisements – Only Designated Routers (DR) send this type of LSA, it contains a list of devices connected to a particular network. This LSA type is kept within a single area.
- LSA Type 3 – Summary Link Advertisements – Only Area Border Routers (ABR) send this type of LSA, it contains a list of inter-area routes and network reachability information. This LSA type is sent into the different areas that are connected to the ABR (i.e. routes are exchanged between connected areas).
- LSA Type 4 – Summary Link Advertisements – Only Area Border Routers (ABR) send this type of LSA, it contains a list of inter-area routes to the Autonomous System Boundary Routers (ASBR) within the OSPF domain. This LSA type is sent into the different areas that are connected to the ABR (i.e. Routes to the different ASBRs in the OSPF domain are exchanged)
- LSA Type 5 – Autonomous System (AS) external link advertisements – Only ASBRs send this type of LSA, it contains a list of external routes that are reachable via the ASBR. This LSA type is flooded throughout the entire OSPF domain.
- LSA Type 7 – Not So Stubby Area advertisements – Only NSSA ASBRs send this type of LSA, it contains a list of external routes that are reachable via the NSSA ASBR. This LSA type differs from LSA type 5 because stubby areas do not allow LSA type 5, the workaround is to use LSA type 7 within the NSSA area which is then converted by the NSSA ABR into LSA type 5 which is then flooded into the rest of the OSPF domain.

- **Type 1** - Represents a router
- **Type 2** - Represents the pseudonode (designated router) for a multiaccess link
- **Type 3** - A network link summary (internal route)
- **Type 4** - Represents an ASBR
- **Type 5** - A route external to the OSPF domain
- **Type 7** - Used in stub areas in place of a type 5 LSA

LSA types 1 and 2 are found in all areas, and are never flooded outside of an area. Whether the other types of LSAs are advertised within an area depends on the area type, and there are many:

- **Backbone area** (area 0)
- **Standard area**
- **Stub area**
- **Totally stubby area**
- **Not-so-stubby area** (NSSA)

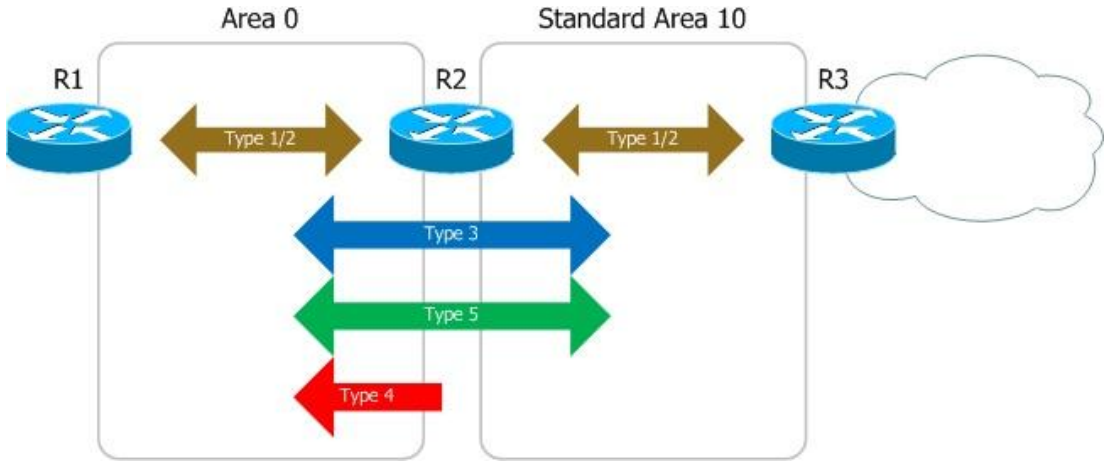
- Stubby – A stubby area is an area that is not able to accept LSA type 5 which contains routes from outside the OSPF domain (Redistributed into OSPF), these are also referred to as external routes. Traffic that is destined for a location outside of the OSPF network is only able to exit the area via a default route (which is injected by the ABR).
- Totally stubby – A totally stubby area is an area that is not able to accept LSA type 3 or 5 which contain routes from outside the OSPF domain and is not able to accept routes from outside the area; traffic is only able to exit the area via a default route (which is injected via the ABR).
- Not-so-stubby – A not-so-stubby area (NSSA) is an area that acts the same as a stubby area with one exception, while a stubby area is not able to accept LSA type 5 and is not able to connect directly to an external routing domain; an NSSA network is able to contain an ASBR (and connect to an external

routing domain) by using an LSA type 7. The routes to this external routing domain are then injected into the backbone (and from there to other areas) by the NSSA ABR. This area is still not able to accept an LSA type 5 from the rest of the OSPF domain.

- Totally NSSA – A totally NSSA is an area that acts the same as a totally stubby area but with the same abilities as a normal NSSA area. As with a normal totally stubby area, a totally NSSA is not able to accept LSA 5's (external) from other areas.

Let's begin by examining a standard area. Note that the backbone area is essentially a standard area which has been designated as the central point to which all other areas connect, so a discussion of standard area behavior largely applies to the backbone area as well.

Standard Areas



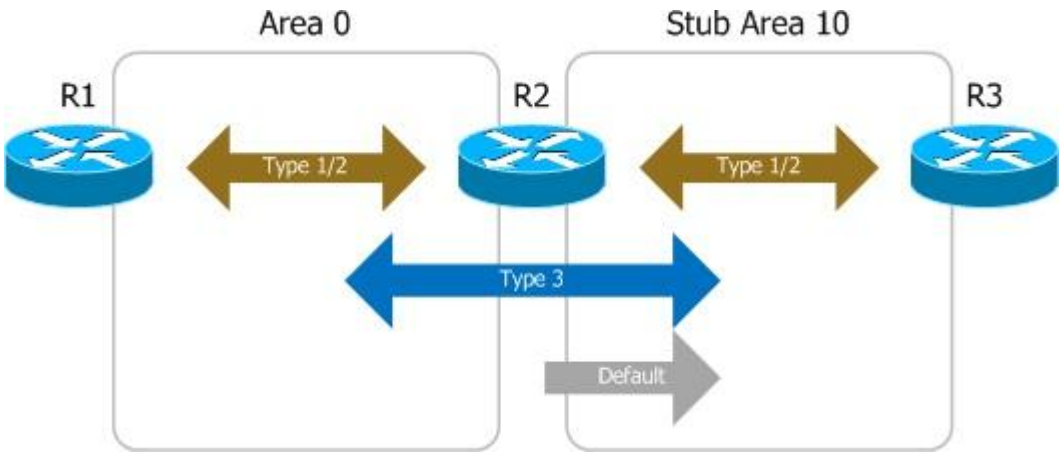
In the example above, router 2 acts as the *area border router (ABR)* between a standard area and the backbone. R3 is redistributing routes from an external domain, and is therefore designated as an *autonomous system boundary router (ASBR)*.

As mentioned, type 1 and 2 LSAs are being flooded between routers sharing a common area. This applies to all area types, as these LSAs are used to build an area's shortest-path tree, and consequently only relevant to a single area. Type 3 and 5 LSAs, which describe internal and external IP routes, respectively, are flooded throughout the backbone and all standard areas. External routes are generated by an ASBR, while internal routes can be generated by any OSPF router.

Note the peculiar case of type 4 LSAs. These LSAs are injected into the backbone by the ABR of an area which contains an ASBR. This is to ensure all other routers in the OSPF domain can reach the ASBR.

Standard areas work fine and ensure optimal routing since all routers know about all routes. However, there are often situations when an area has limited access to the rest of the network, and maintaining a full link state database is unnecessary. Additionally, an area may contain low-end routers incapable of maintaining a full database for a large OSPF network. Such areas can be configured to block certain LSA types and become lightweight *stub areas*.

Stub Areas



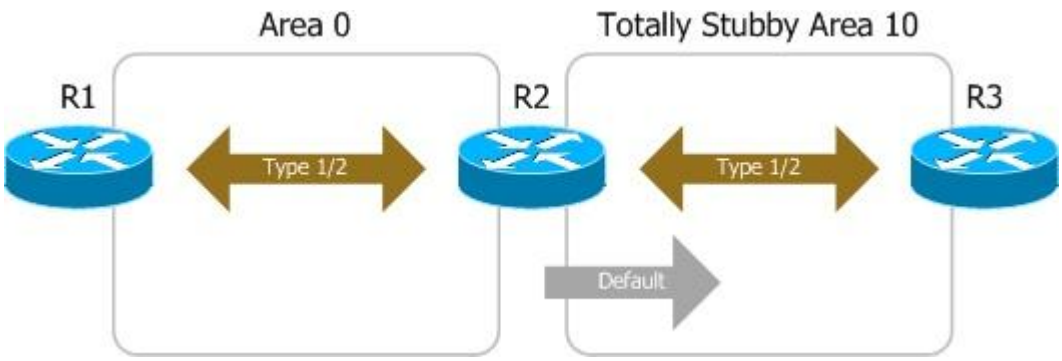
In this next example, R2 and R3 share a common stub area. Instead of propagating external routes (type 5 LSAs) into the area, the ABR injects a type 3 LSA containing a default route into the stub area. This ensures that routers in the stub area will be able to route traffic to external destinations without having to maintain all of the individual external routes. Because external routes are not received by the stub area, ABRs also do not forward type 4 LSAs from other areas into the stub.

For an area to become a stub, all routers belonging to it must be configured to operate as such. Stub routers and non-stub routers will not form adjacencies.

```
Router(config-router)# area 10 stub
```

This idea of substituting a single default route for many specific routes can be applied to internal routes as well, which is the case of *totally stubby areas*.

Totally Stub Areas

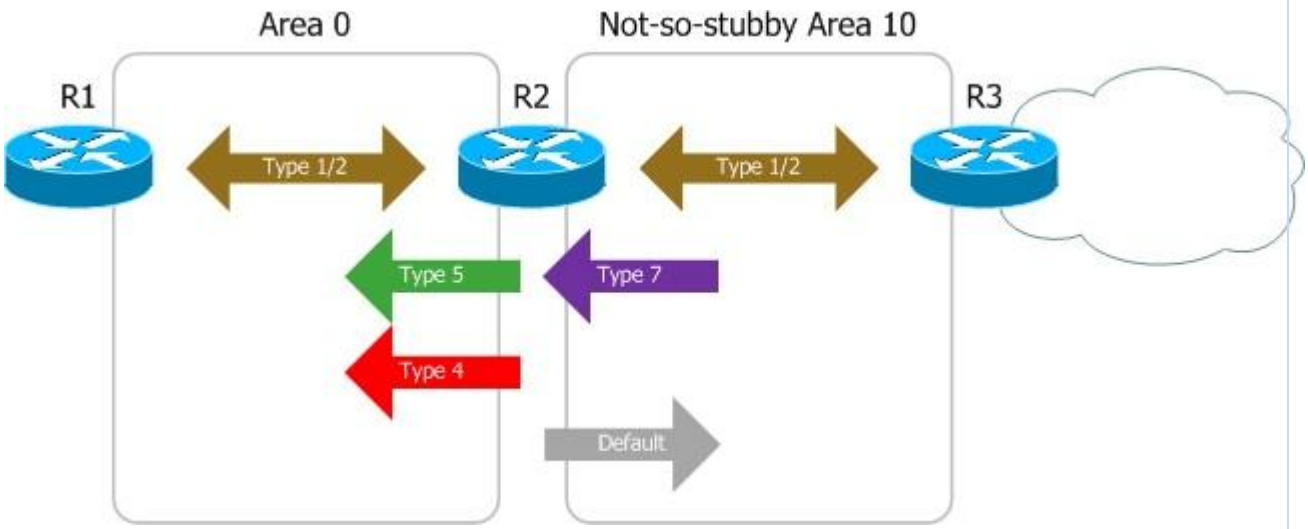


Like stub areas, totally stubby areas do not receive type 4 or 5 LSAs from their ABRs. However, they also do not receive type 3 LSAs; all routing out of the area relies on the single default route injected by the ABR.A stub area is extended to a totally stubby area by configuring all of its ABRs with the `no-summary` parameter:

```
Router (config-router) # area 10 stub no-summary
```

Stub and totally stubby areas can certainly be convenient to reduce the resource utilization of routers in portions of the network not requiring full routing knowledge. However, neither type can contain an ASBR, as type 4 and 5 LSAs are not permitted inside the area. To solve this problem, and in what is arguably the worst naming decision ever made, Cisco introduced the concept of a *not-so-stubby area (NSSA)*.

Not-so-Stubby Areas



An NSSA makes use of type 7 LSAs, which are essentially type 5 LSAs in disguise. This allows an ASBR to advertise external links to an ABR, which converts the type 7 LSAs into type 5 before flooding them to the rest of the OSPF domain. An NSSA can function as either a stub or totally stubby area. To designate a normal (stub) NSSA, all routers in the area must be so configured:

```
Router (config-router) # area 10 nssa
```

Type 3 LSAs will pass into and out of the area. Unlike a normal stub area, the ABR will *not* inject a default route into an NSSA unless explicitly configured to do so. As traffic cannot be routed to external destinations without a default route, you'll probably want to include one by appending `default-information-originate`.

```
Router (config-router) # area 10 nssa default-information-originate
```

To expand an NSSA to function as a totally stubby area, eliminating type 3 LSAs, all of its ABRs must be configured with the `no-summary` parameter:

```
Router(config-router)# area 10 nssa no-summary
```

The ABR of a totally stubby NSSA (or not-so-totally-stubby area, if you prefer) injects a default route without any further configuration.

Summary

- **Standard areas** can contain LSAs of type 1, 2, 3, 4, and 5, and may contain an ASBR. The backbone is considered a standard area.
- **Stub areas** can contain type 1, 2, and 3 LSAs. A default route is substituted for external routes.
- **Totally stubby areas** can only contain type 1 and 2 LSAs, and a single type 3 LSA. The type 3 LSA describes a default route, substituted for all external and inter-area routes.
- **Not-so-stubby areas** implement stub or totally stubby functionality yet contain an ASBR. Type 7 LSAs generated by the ASBR are converted to type 5 by ABRs to be flooded to the rest of the OSPF domain.