ROUTING
PROTOCOLS
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TWO PROTOCOL FAMILIES

Two Kinds of Protocols

- Interior Gateway Protocol (IGP)
  - Intra-domain routing
- Exterior Gateway Protocol (EGP)
  - Inter-domain routing

域间路由

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面向不同的对象，有不同的设计准测

Different objectives

↓

Different design criteria

IGP Features

分发拓扑信息

→ Distribute topological information

→ Choose routes based on topological information

→ Find “best” route

根据拓扑信息选择最佳路由

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EGP Features

- → Distribute Autonomous System information 分发自治系统信息
- → Distribute administrative costs
- → Decide based on policies 分发管理开销
  - → Find “preferred” route

基于策略选择喜好路由

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IGP – Distance Vector

路由信息协议

- → RIP: Routing Information Protocol
- → IGRP: Interior Gateway Routing Protocol

内部网关路由协议

  - → E-IGRP: Enhanced IGRP

增强内部网关内部路由协议

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IGP – Link State

开放最短路径优先

- → OSPF: Open Shortest Path First
- → Integrated IS-IS

被整合到了IS-IS协议中了

EGP

边界网关协议

- BGP: Border Gateway Protocol
- IDRP: Inter Domain Routing Protocol

国际域名路由协议

- Static routing also a viable option

静态路由也是一个可行的选择

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INTERIOR GATEWAY PROTOCOLS

RIP

- Originally developed for another architecture
- RFC 1O58 (1988) and RFC 1388 (1993)
- Implemented also by Unix/Linux hosts

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Features

- → Hop count 跳数统计
- → At most 15 hops 最多15跳
- → Periodic update messages 周期性的更新信息
  - → Distance vectors DV
  - → Every 3O s
    - → Time-out based operation
- → Convergence: 3 min 收敛： 3Min

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IGRP

思科专有

- Cisco Systems proprietary
- It overcomes some of the shortcomings of RIP

克服了RIP的部分缺点

- For a while, the only alternative to RIP

有时候，对于RIP是唯一的替代选项

Features

- Articulated metrics
  - Delay 延时
  - Bandwidth 带宽
  - Reliability 可靠性
  - Load 负载
  - Maximum packet length
- Multipath routing 多路径路由

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OSPF

- RFC 1247 (1991) and RFC 1583 (1994)
- Hierarchical routing 等级路由
  - Routing domain divided in areas 按区域划分路由域
  - Aggregation of information among areas

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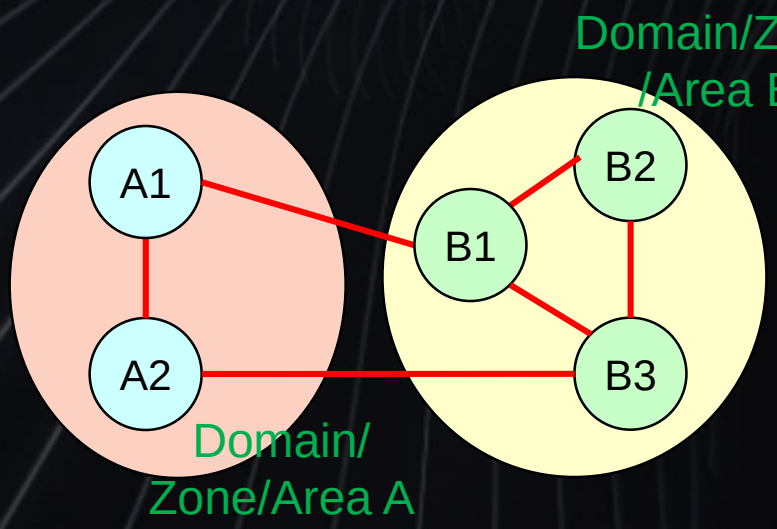
Hierarchical Routing

路由器知道其他域的所有信息

- Routers know all details of their domain/zone/area
- Routers have limited or no knowledge about the outside

路由器知道很少外面的信息

- Can be iterated



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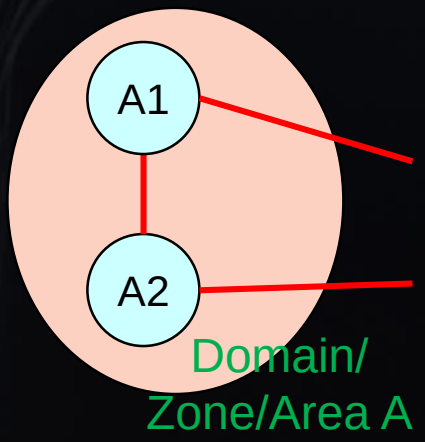
Strictly Hierarchical Routing

No knowledge/visibility outside own area/domain/zone 完全不知道外面的信息

- → When the destination of a packet is not in the area, it is forwarded towards an edge router 当一个包的目标地址不属于内部，它会被转发到边界路由
- → Maximum scale 最大饱和
- → Limited routing capability 限制了路由功能



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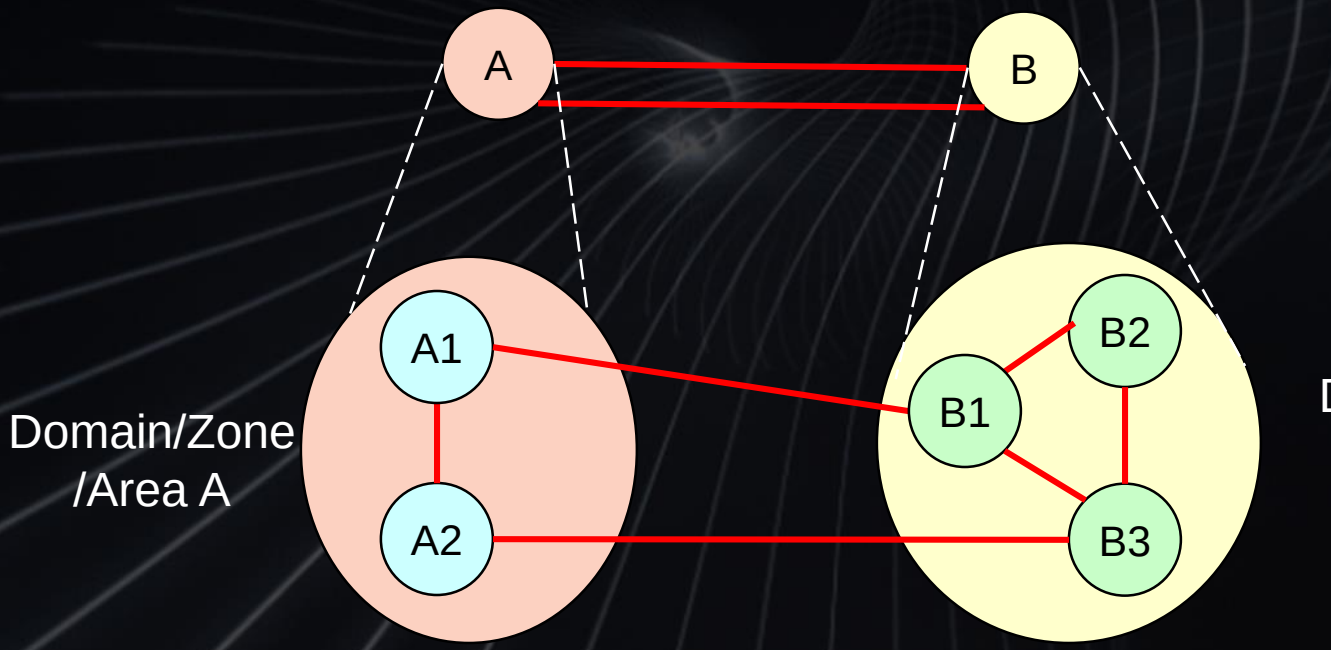
Strictly Hierarchical Routing

Higher layer routers have area/domain/zone level view



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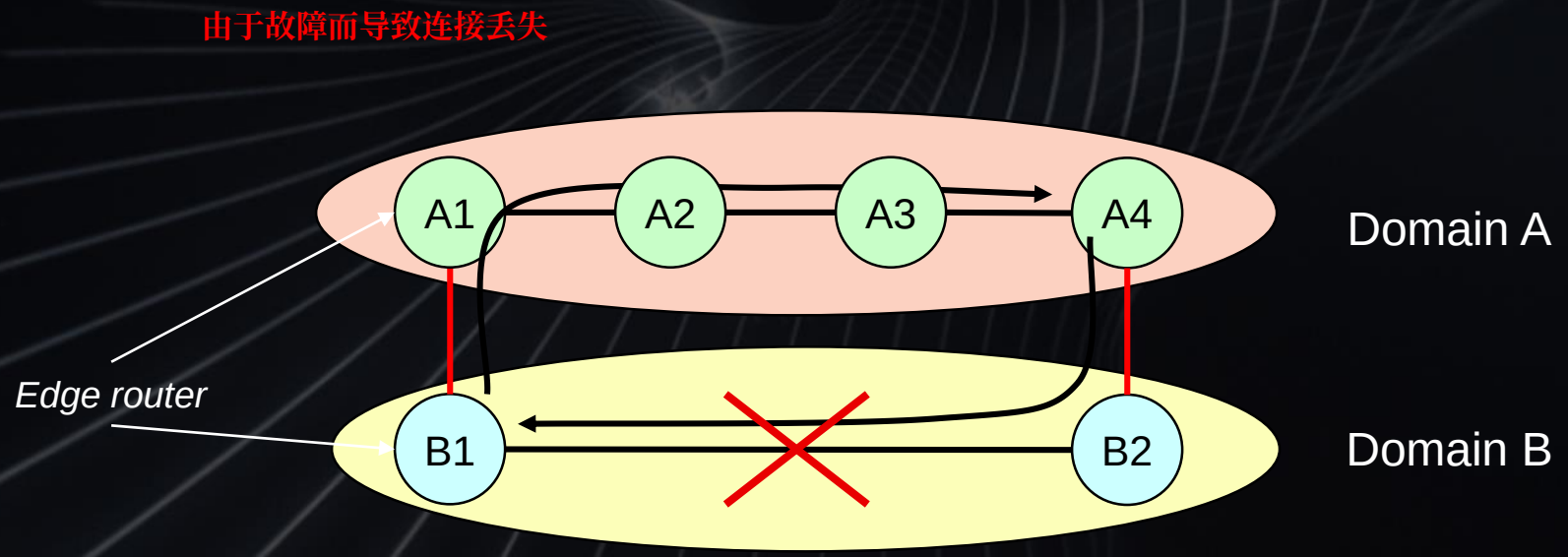
Strictly Hierarchical Routing

- Sub-optimal paths
- Loss of connectivity due to faults



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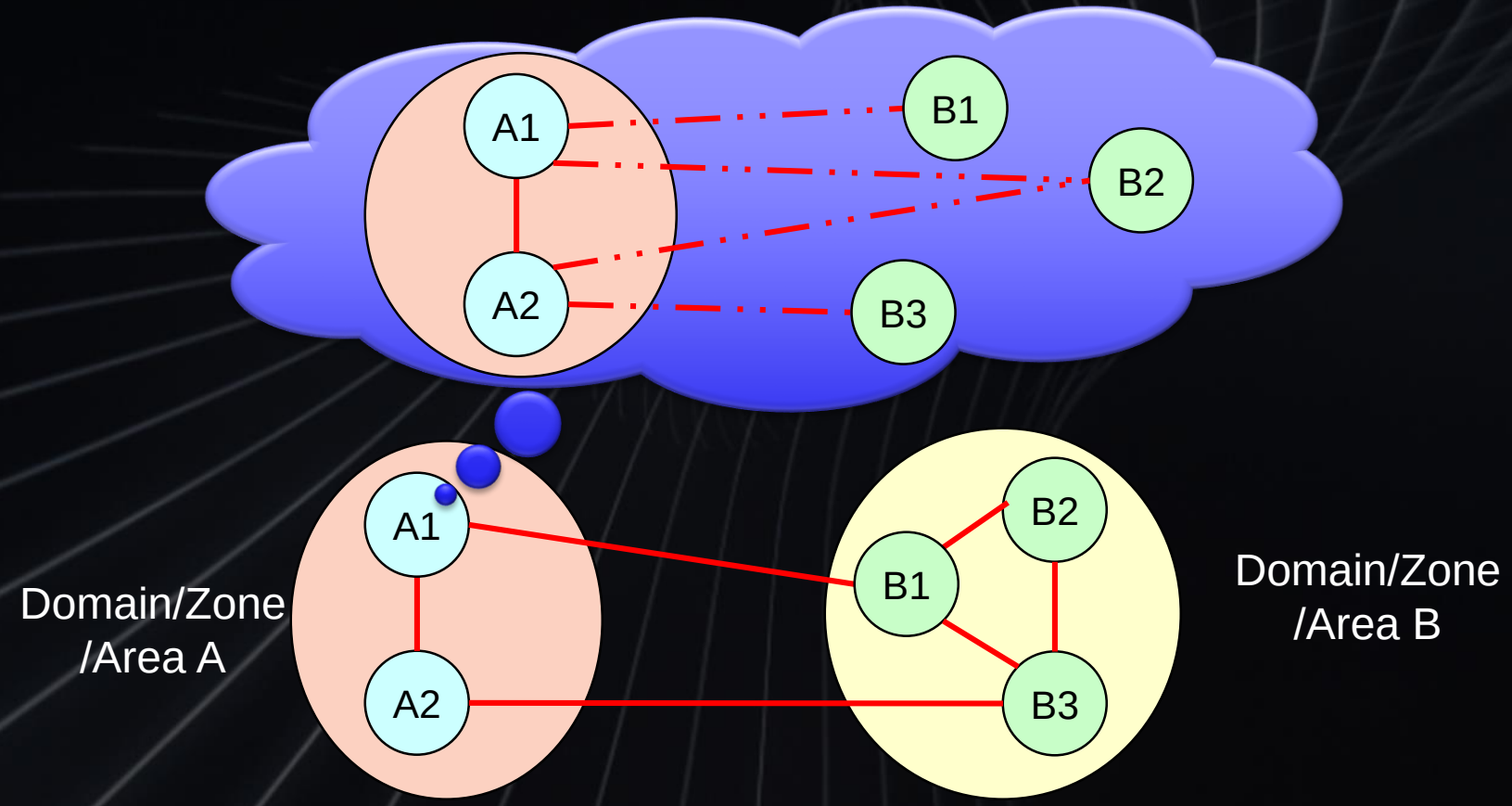
宽松的分层路由

Loosely Hierarchical Routing

Routers have high level knowledge of the outside

路由有更高等级的外部信息



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Loosely Hierarchical Routing

- Less scalability 更低的扩展性
  - Routers have to store and exchange more information
- Does not require strictly hierarchical addressing 并不要求严格的等级寻址
  - All host in domain B do not need a common identifier 在域B中的所有主机并不需要通用标识符
    - Prefix 前缀
  - Possible in IPv4

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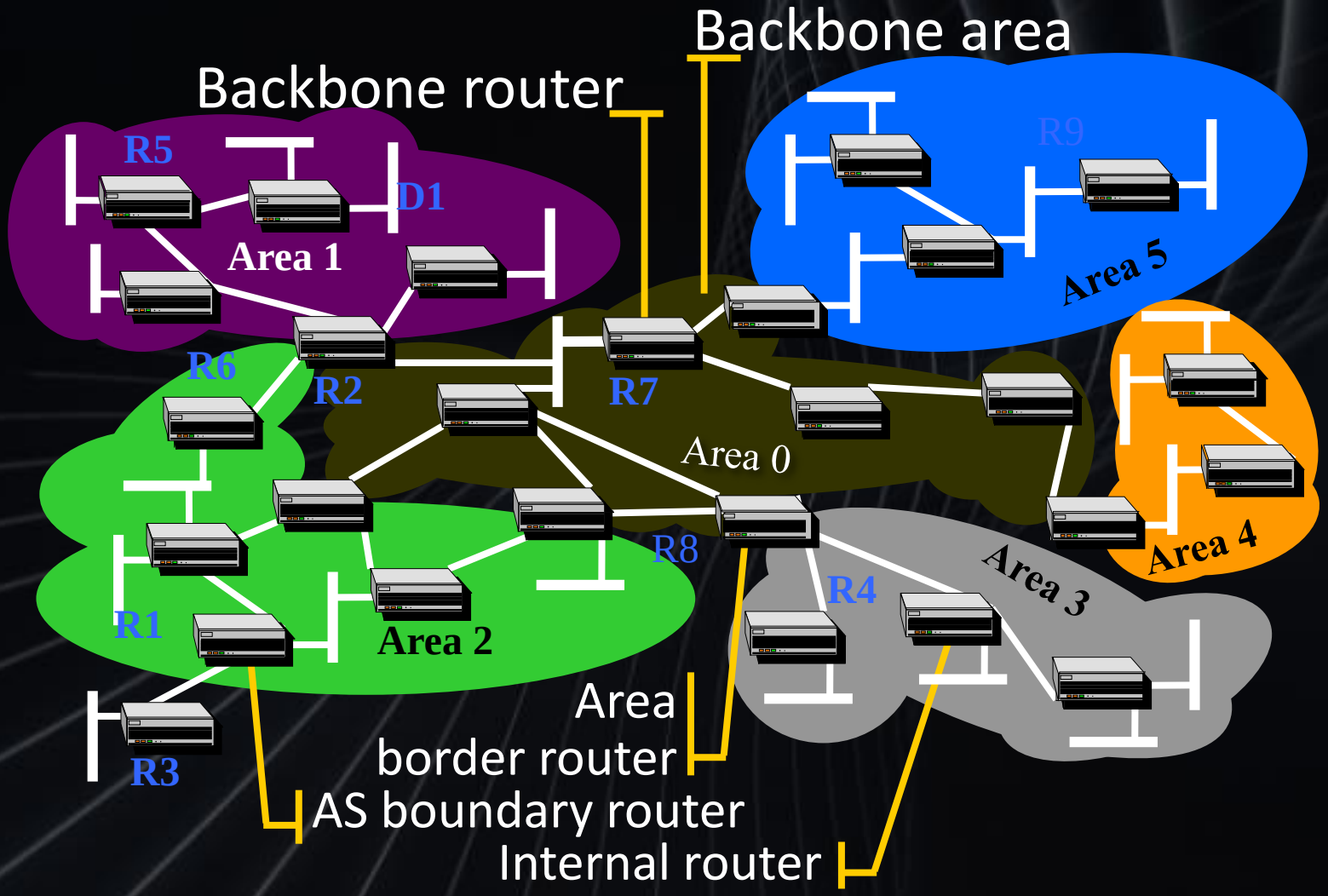
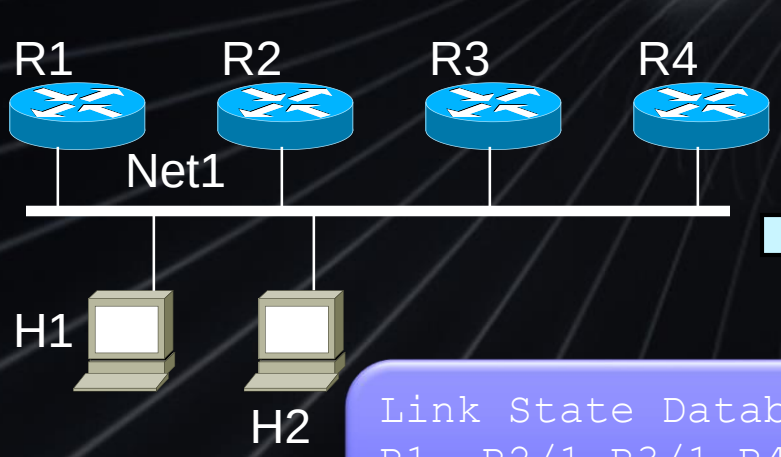
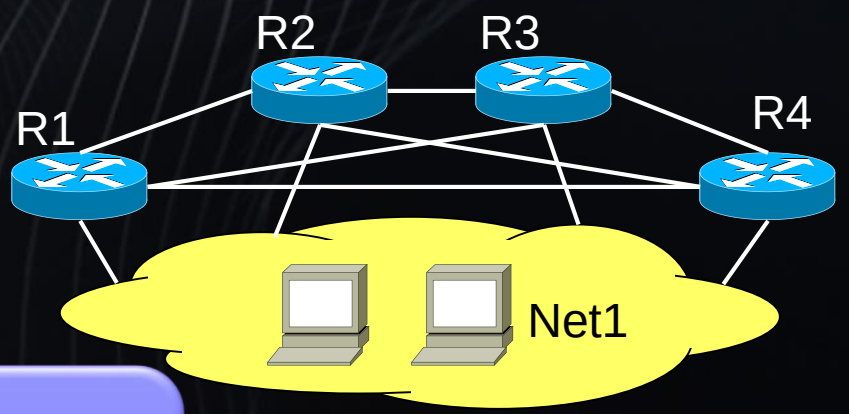
OSPF Architecture



Broadcast Networks

- N routers = N2 adjacencies 邻接项
  - N^2 links
- Dijkstra complexity is linear with number of links Dijkstra的复杂度是随着链接数线性增长的






```
Link State Database
R1   R2/1 R3/1 R4/1 Net1/1
R2   R1/1 R3/1 R4/1 Net1/1
R3   R1/1 R2/1 R4/1 Net1/1
R4   R1/1 R2/1 R3/1 Net1/1
```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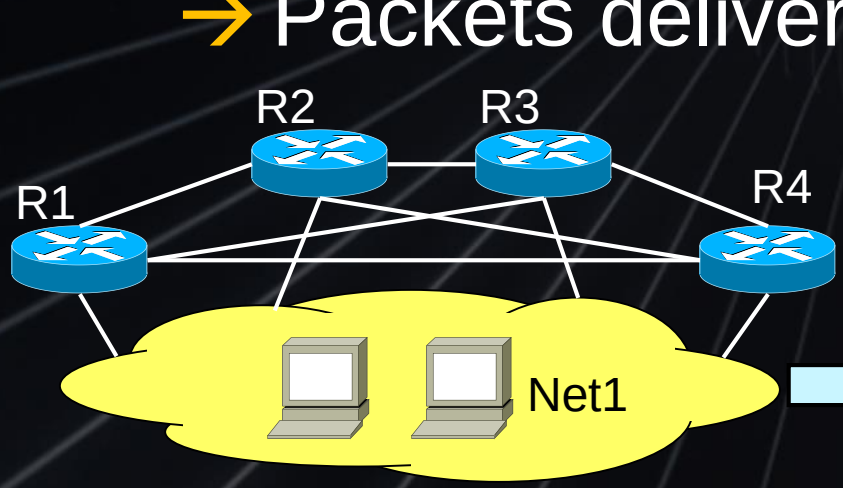
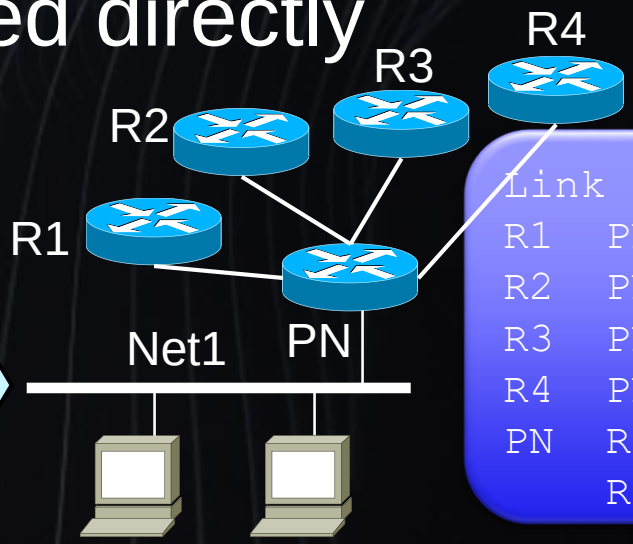
Broadcast Networks

- Pseudo-node
- Virtual node to transform full mesh into star 虚拟节点把网状结构转换成星状
  - Role played by one of the routers (election) 虚拟节点由其中的一个路由来扮演
- Only for (proactive) routing 主要用于非自适应路由中的主动路由
  - Packets delivered directly 数据包直接派送






```
Link State Database
R1   PN/1
R2   PN/1
R3   PN/1
R4   PN/1
PN   R1/1 R2/1 R3/1
     R4/1 Net1/1
```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Integrated IS-IS

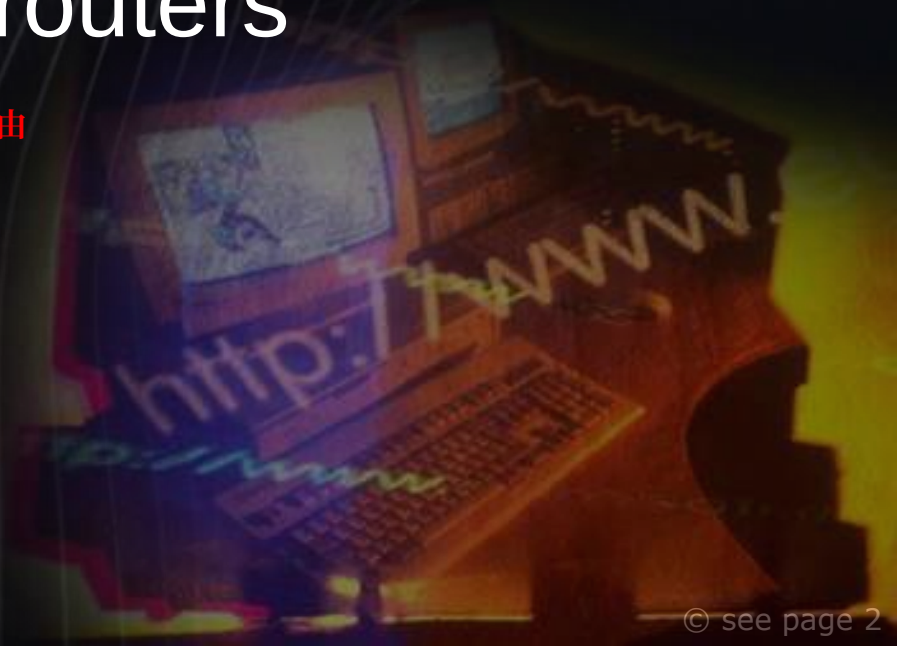
OSI协议的拓展

- → Extension of an OSI protocol
- → Hierarchical routing

等级路由

  - → Different level routers

不同等级的路由



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- Widely deployed before OSPF was available 在OSPF可用前广泛部署
  - Large networks 大型网络
  - ISPs
- Still in use
  - Do not change what works

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EXTERIOR GATEWAY PROTOCOLS

外部网关协议

BGP

- Currently Version 4
  - RFC 1654 (1994)
- Path vector
  - AS sequence to destination
- Rich set of attributes
- Configurable route computation policy

可配置路由计算策略

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InterDomain Routing Protocol (IDRP)

域间路由协议

- → Evolution of BGP for OSI

  BGP针对于OSI的进化版

  - → Ported back to TCP/IP

    移植回TCP/IP

- → Supposed to be “the” choice for IPv6

  应该是IPv6的选择

- → Not used a lot

  使用并不广泛