

Multi-constraint Macro-routing by using the extended full-mesh aggregation

Sanda-Maria Dragoş and Martin Collier

Hierarchical routing protocols

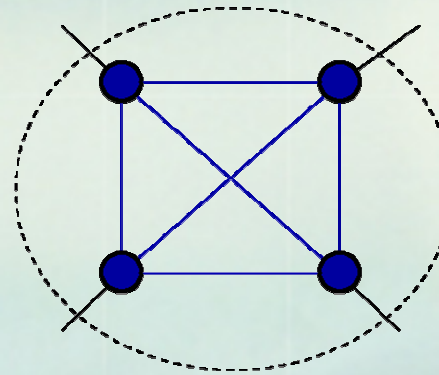
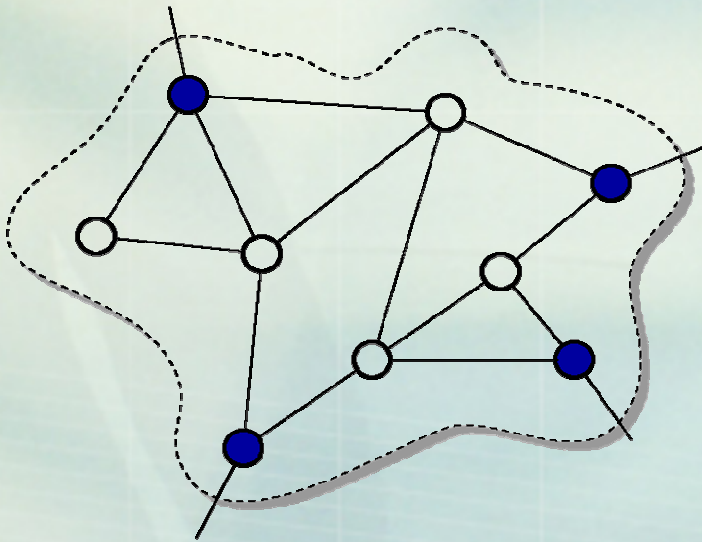
Why do we need them?

- The Internet increases in size & user demands
- The Internet Service Providers (ISP) deploy:
 - *Traffic Engineering*
 - *Quality of Service routing*
- *Scalability issues*
 - *Storage overhead*
 - *Computational overhead*
 - *Communication overhead*

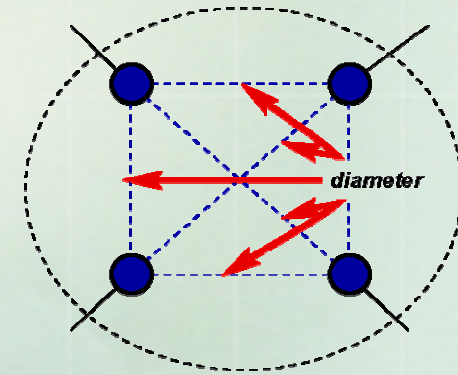
Hierarchical routing protocols

Topology aggregation

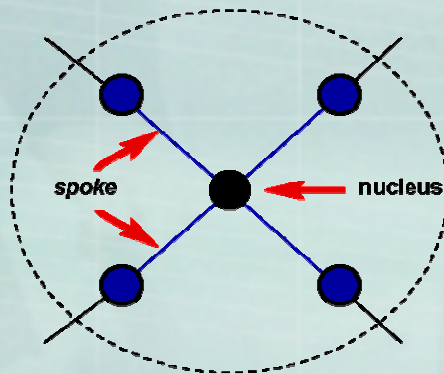
The network is divided into domains. Detailed routing information is delivered only inside each domain, and only aggregated routing information is transmitted across domain boundaries.



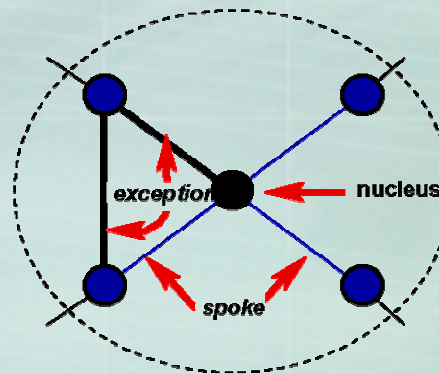
Full-Mesh



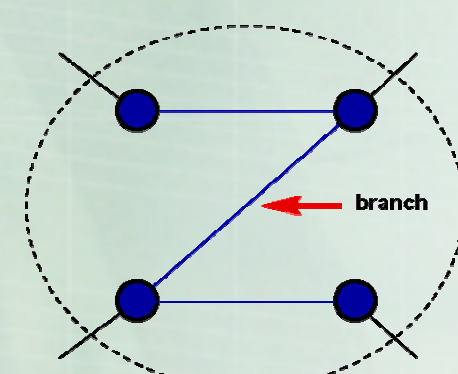
Symmetric Node



Star



Complex-Node

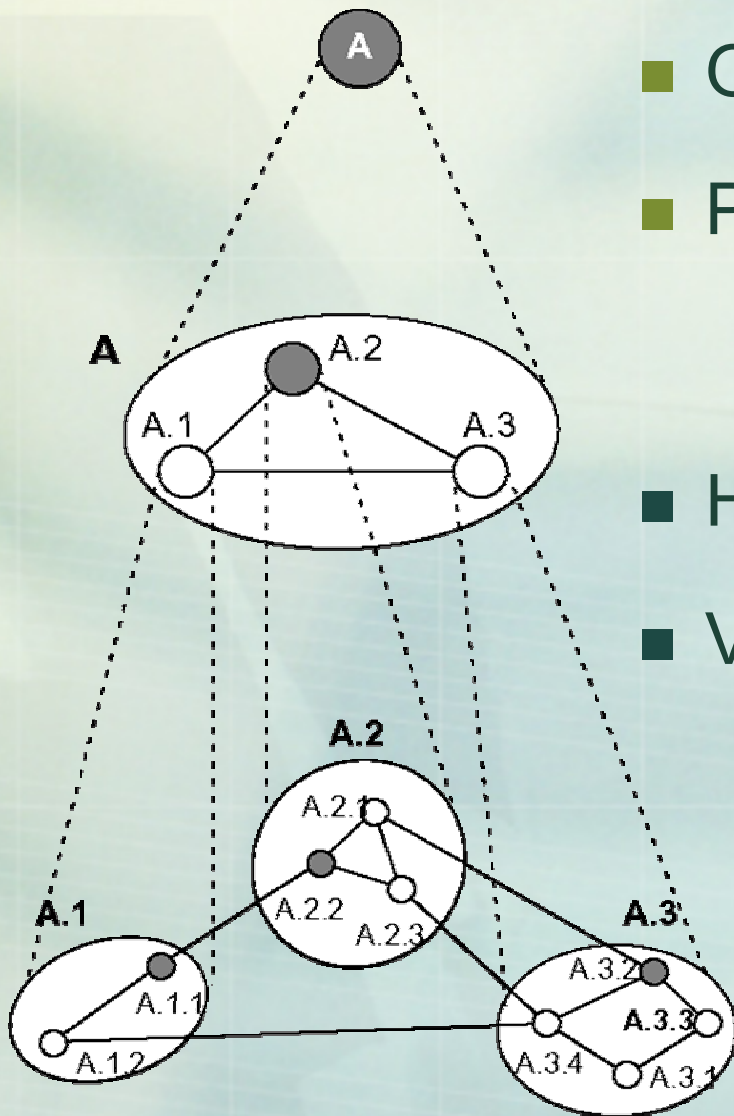


Spanning Tree

Hierarchical routing protocols

Examples

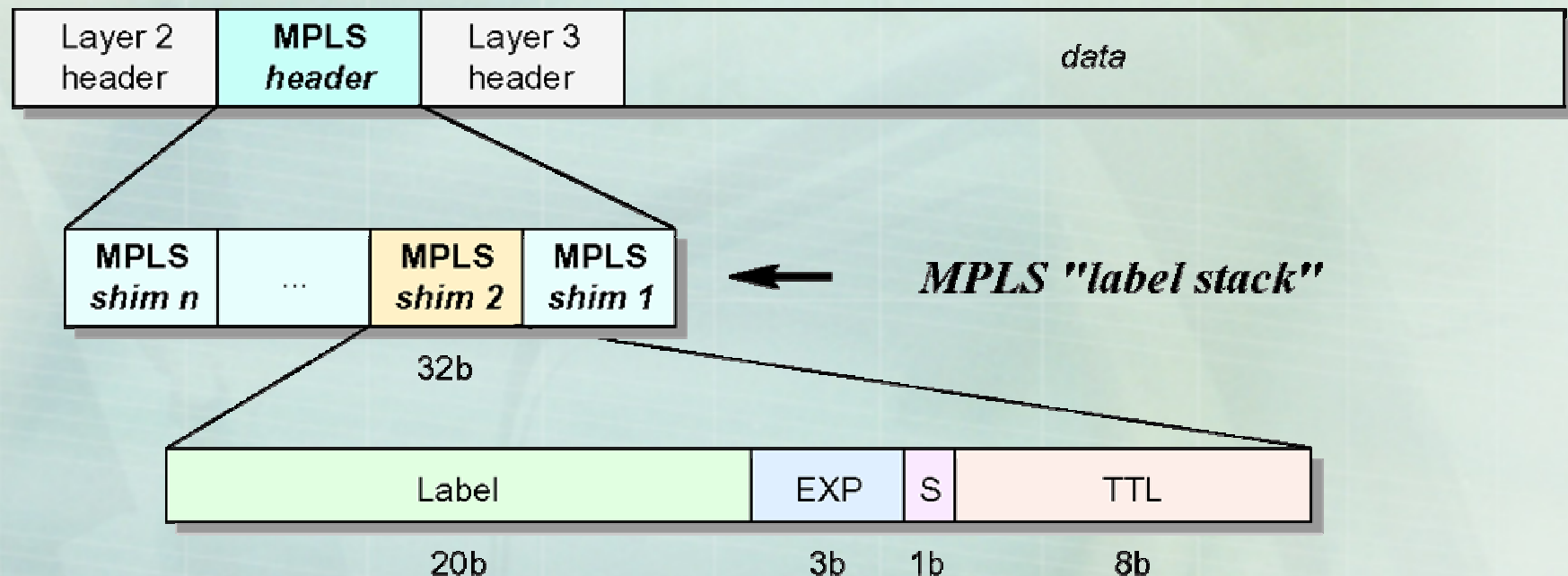
- Open Shortest Path First (OSPF)
- Private Network-to-Network Interface (PNNI)
- Hierarchical Distributed Protocol (HDP)
- Viewserver Architecture



Multi-protocol Label Switching (MPLS)

Why?

- Quality of Service & Traffic Engineering
- *hierarchical forwarding*



Mobile Agents

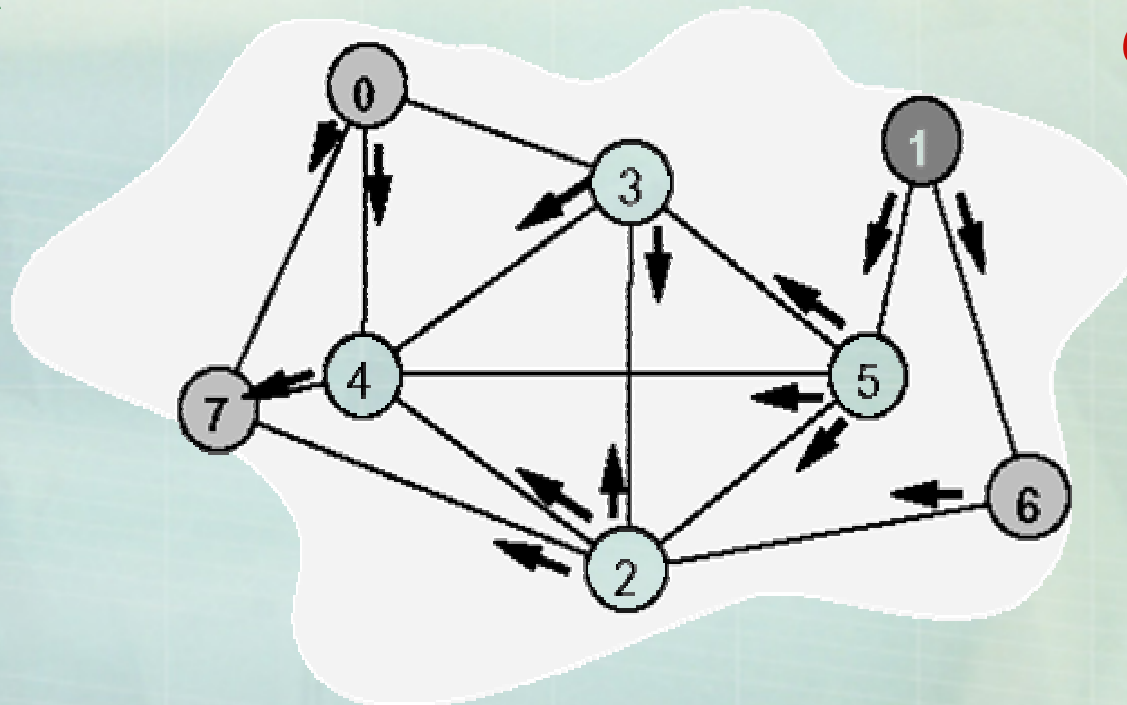
In network routing

A *mobile (software) agent* is: a computational entity

- which acts on behalf of others,
- is *autonomous, proactive, and reactive*,
- exhibits capabilities to *learn, cooperate, and move*.

advantages

- ✓ flexibility
- ✓ modularity
- ✓ scalability
- ✓ adaptability
- ✓ robustness



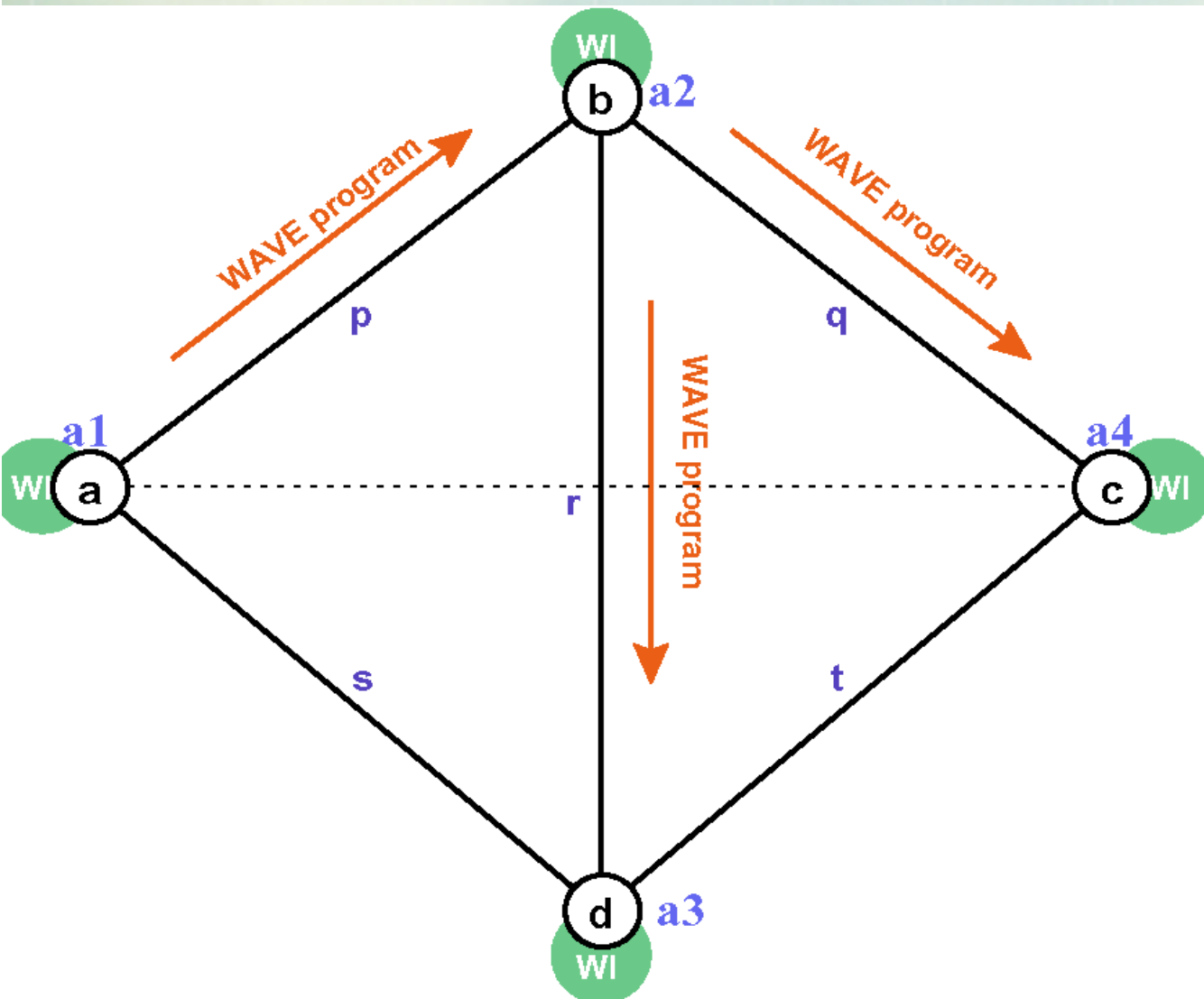
disadvantages

- efficiency
- security
- provability

Mobile Agents

The WAVE technology

... is based on spatial matching of recursively defined strings in the navigational WAVE language with the network topology.



WAVE programs

- recursive code
- dynamically self-spreading
- may be injected from any agent
- propagates together with intermediate data
- *very compact*: (Ex: finding the shortest path three in a link-weighted network:)

@#a.F=0.RP(N~,F<N.N=F.N1=P.\$.F+L)

Macro-routing

hierarchical routing protocol designed for *MPLS* networks that uses for the routing process mobile agents called *waves*

1. Determination of participant domains

- upwards search for the root
- downwards search for the participant domains

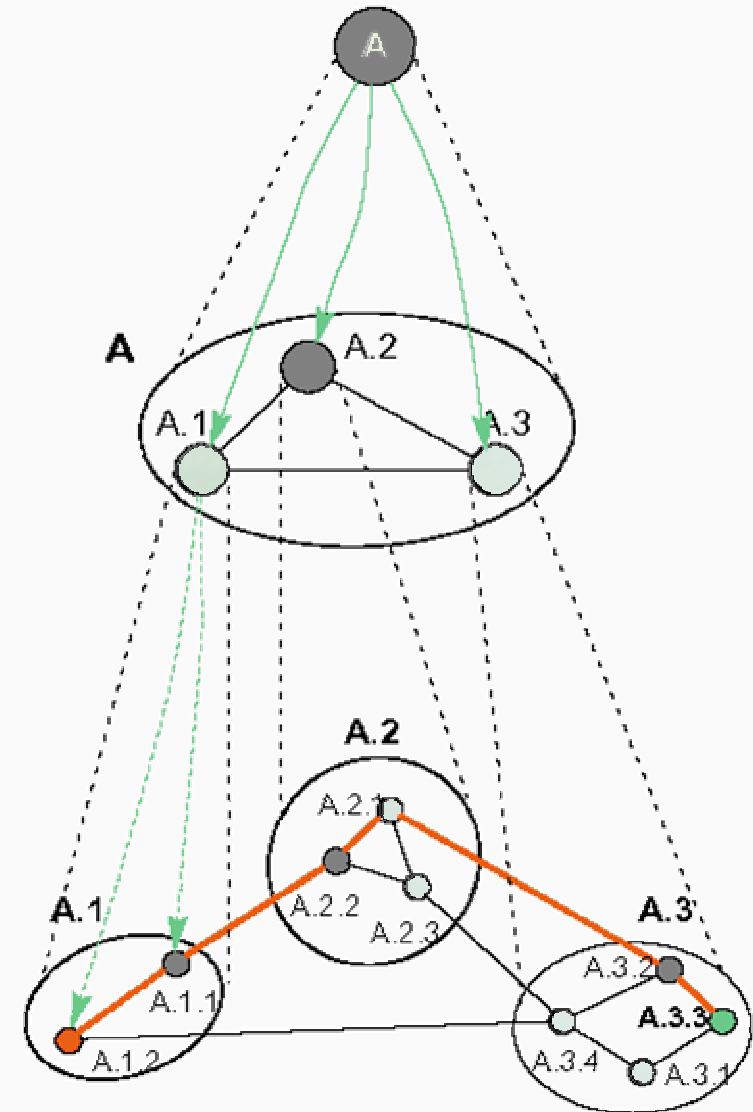
2. Path computation

- create the aggregate representation for every domain
- build the next hierarchical level

- repeat the process until having one domain

3. Path reservation and set-up

- reserve the resources
- set the Label Switched Paths (LSPs)



Macro-routing

Advantages

- no routing information dissemination
- overcomes inaccurate aggregation by using the *full-mesh* aggregation
- parallel processing
- distributed processing with multiple simple tasks

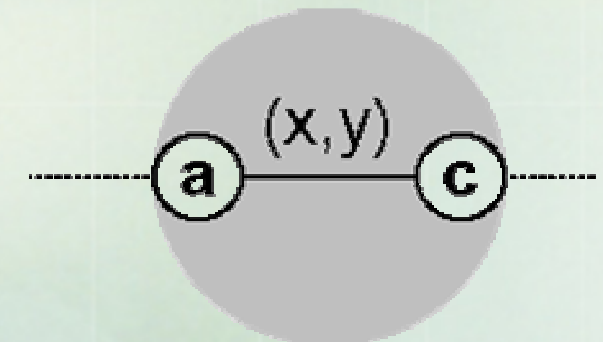
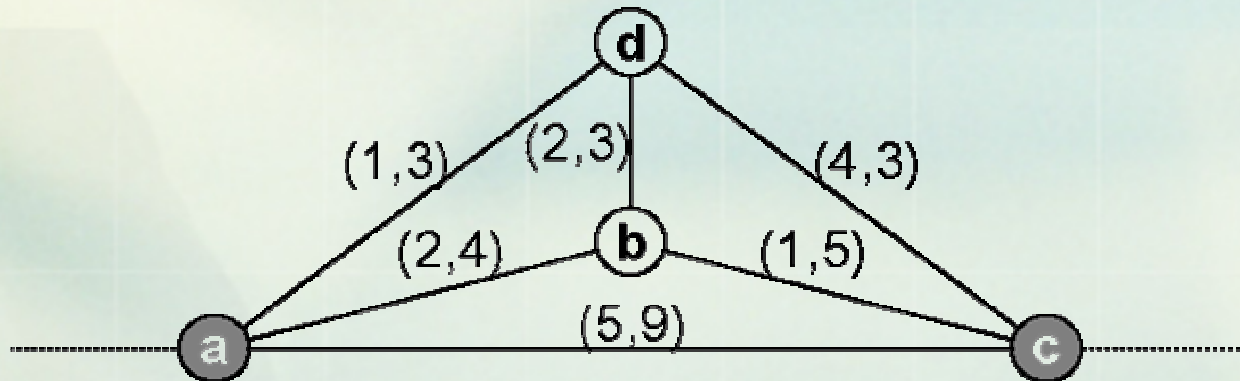
- finds the best path
- finds multiple paths

Macro-routing

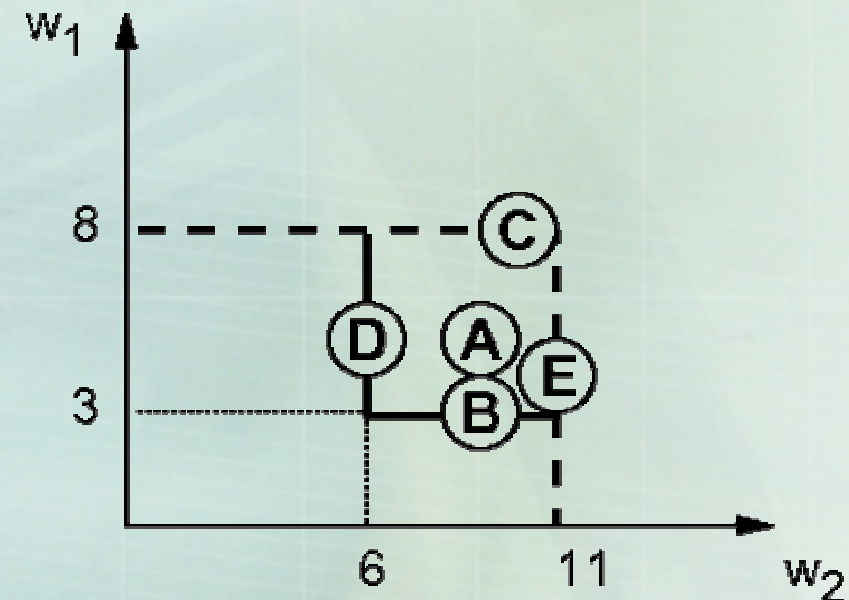
Disadvantages

- Might generate too much traffic
(see results presented at GLOBECOM 2006)
- Does not solve the multi-constrained problem

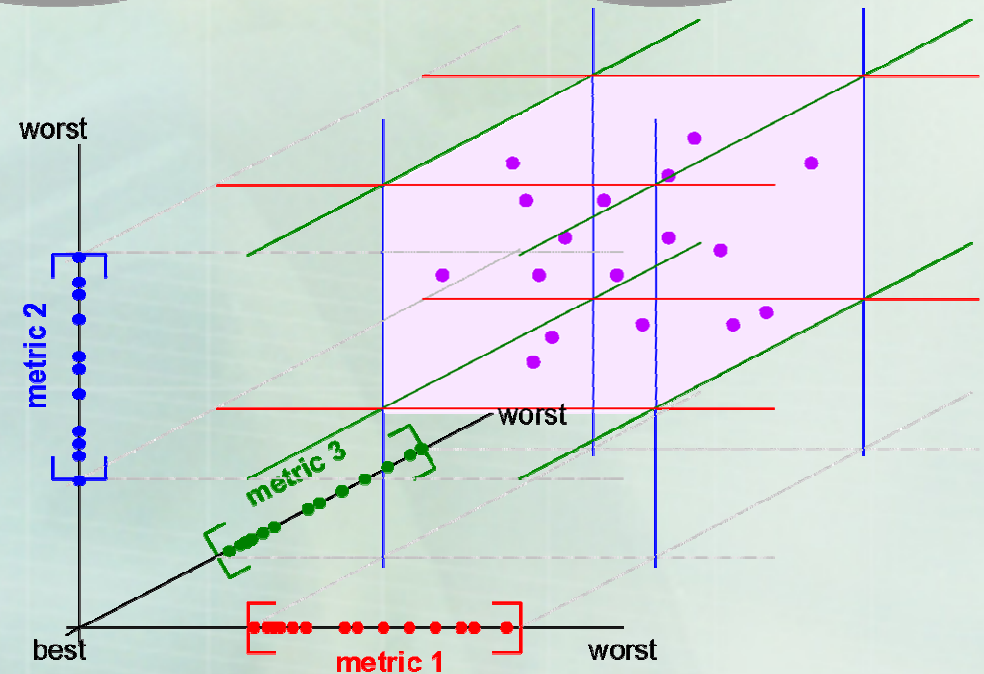
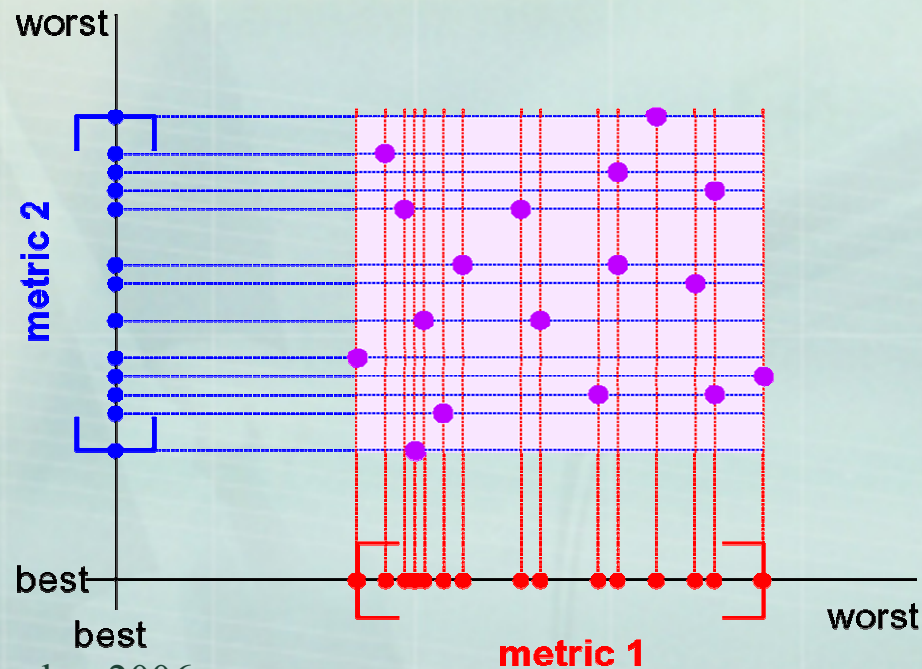
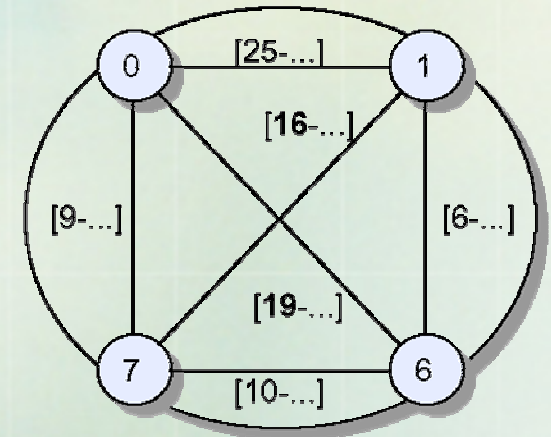
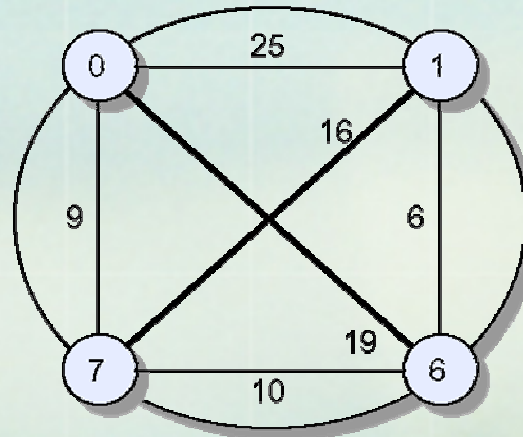
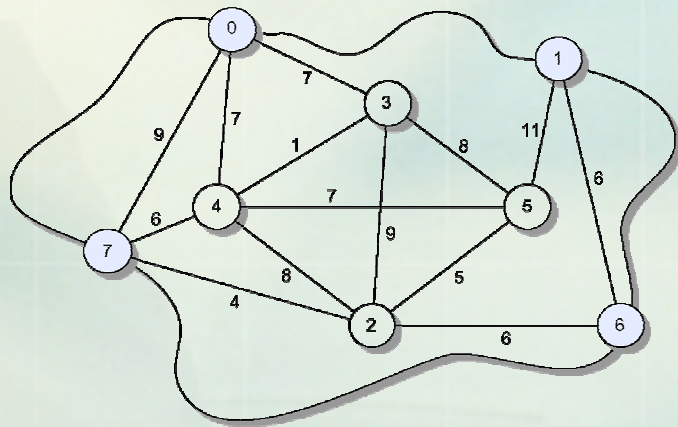
Multi-constrained Macro-routing



- A. a-c = (5,9)
- B. a-b-c = (3,9)
- C. a-b-d-c = (8,10)
- D. a-d-c = (5,6)
- E. a-d-b-c = (4,11)

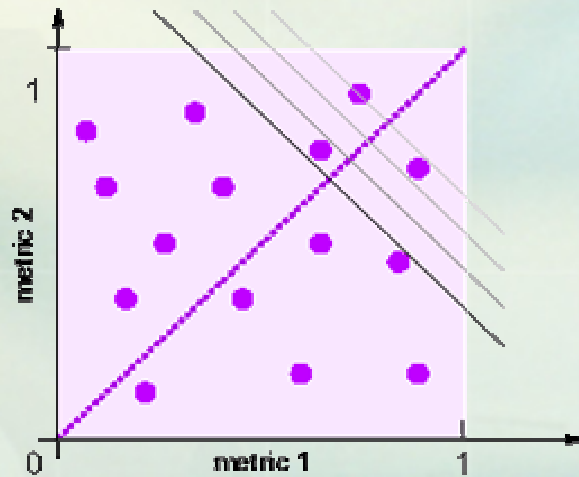


The Extended Full-Mesh aggregation

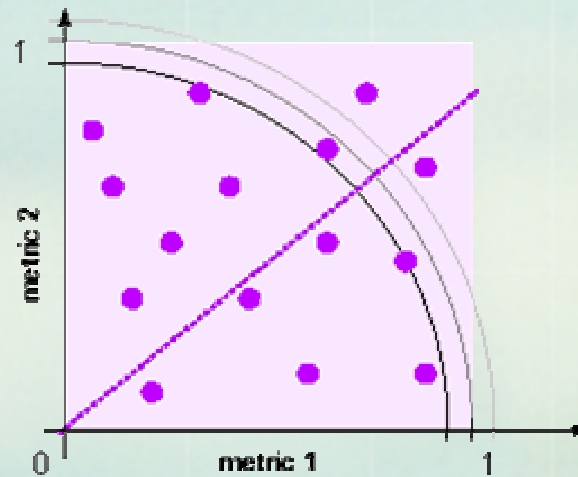


Determining the EFM interval

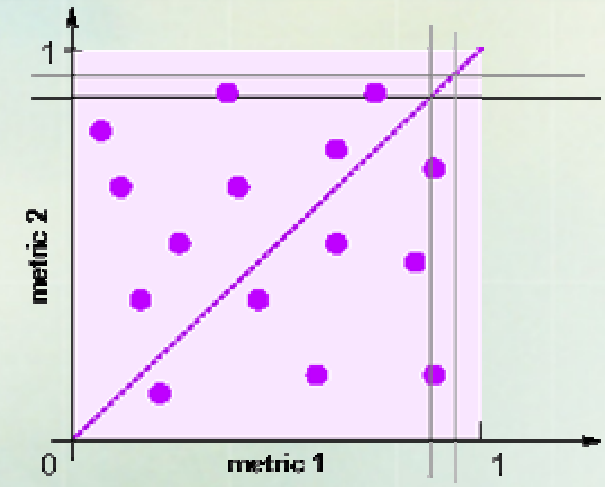
■ Truncation methods



(a) *normal* method

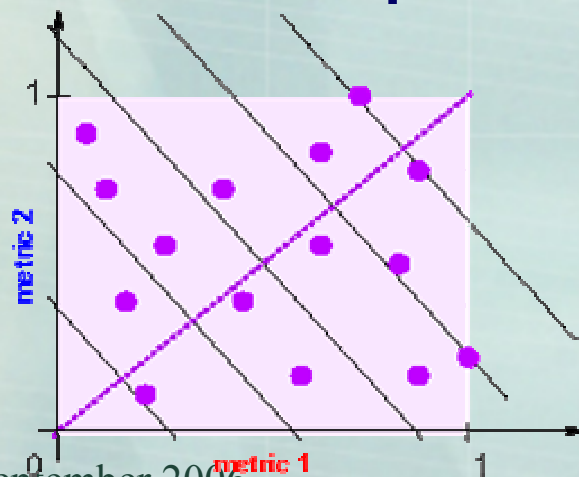


(b) *radius* method

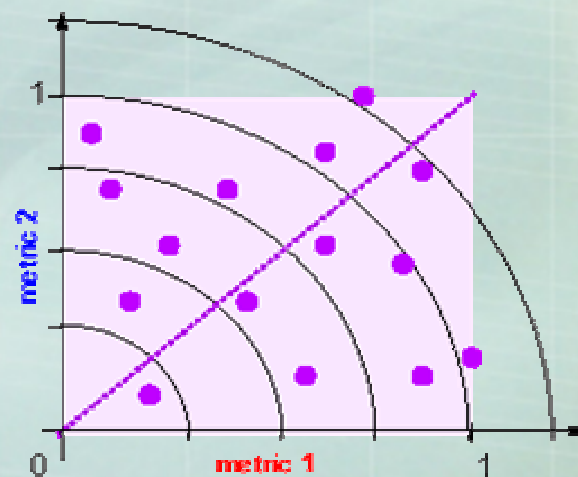


(c) *simple* method

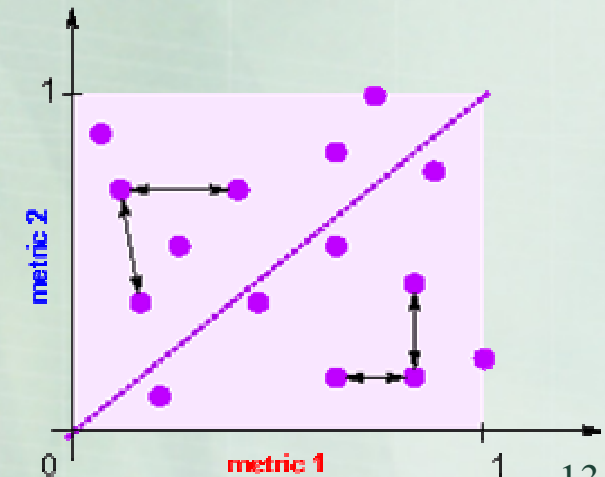
■ Dispersal methods



(a) *normal* method



(b) *radius* method



(c) *distance* method

Conclusions

■ Macro-routing

- a new approach for hierarchical routing
- no information dissemination as the routing information is consulted *in situ*

■ Multi-constraint Macro-routing

- Macro-routing + multi-constraint routing

■ The extended full-mesh aggregation

- Allows more paths to be considered
- Increases the chances of finding a viable path
- It might generate too much traffic
- A number of techniques for limiting the EFM representation

