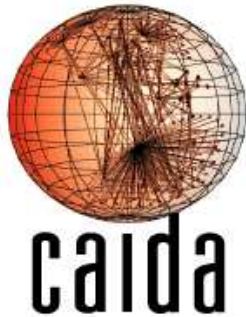


# Atomised Routing

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<http://www.caida.org/projects/routing/atoms/>



## Motivation

- Observation: many prefixes share AS path in all RouteViews / RIPE peers
- BGP policy atom: set of prefixes that share AS path
- Routed the same

## Motivation

Fewer atoms than prefixes + atoms relatively stable:

- 8 May 2003 RouteViews data:
  - around 33000 atoms
  - covering around 113000 prefixes
  - (15400 ASes)
- Stability over 8 hours:
  - 4.9% of atoms undergo prefix membership change
  - 2-3% of prefixes change atom membership  
(Tel Aviv University, 2002)

## Apply to routing?

- Summarise prefixes of atom into one routed object
- Incorporate into BGP

Reduce number of routed objects in Default-Free Zone (DFZ):

- Shrink routing tables and forwarding tables
- Perform routing updates per atom, not per prefix
- Potentially improved convergence

## Remainder of talk

- Architecture
- Incremental deployment
- Status and unresolved issues

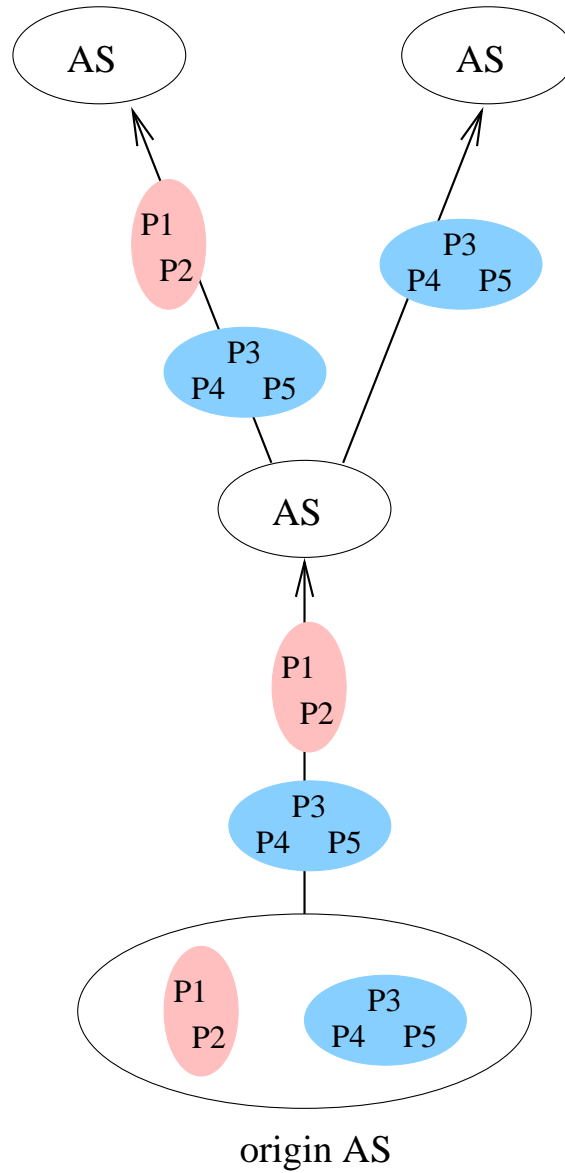
# Architecture

- Origination of atoms
- Overview of routing and forwarding
- Routing outside DFZ
- Routing inside DFZ
- Forwarding inside DFZ
- Forwarding outside DFZ

## Architecture — Origination of atoms

- To be *declared* by origin ASes
- These ASes partition prefixes into atoms and announce
- Prefixes can be IPv4 or IPv6

# Architecture — Example of declared atom



# Architecture — Overview of routing

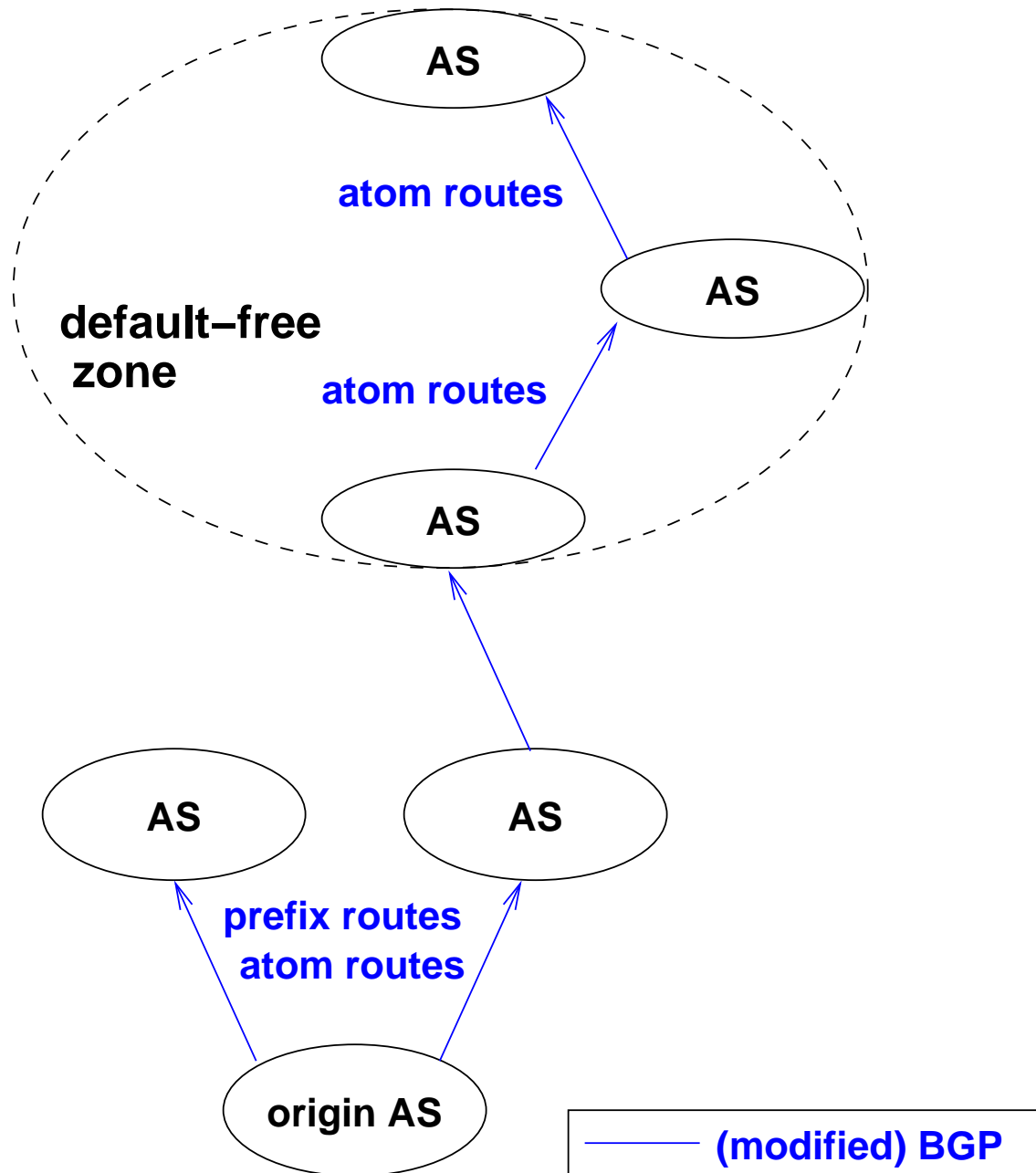
Two functions:

- Atom routing
  - Atom is represented by an atom ID
  - Atom ID syntactically a prefix (unrelated to prefixes in atom)
  - Reason: BGP can route atom IDs
- Atom membership
  - Distributes {atom ID  $\leftrightarrow$  prefix} mapping

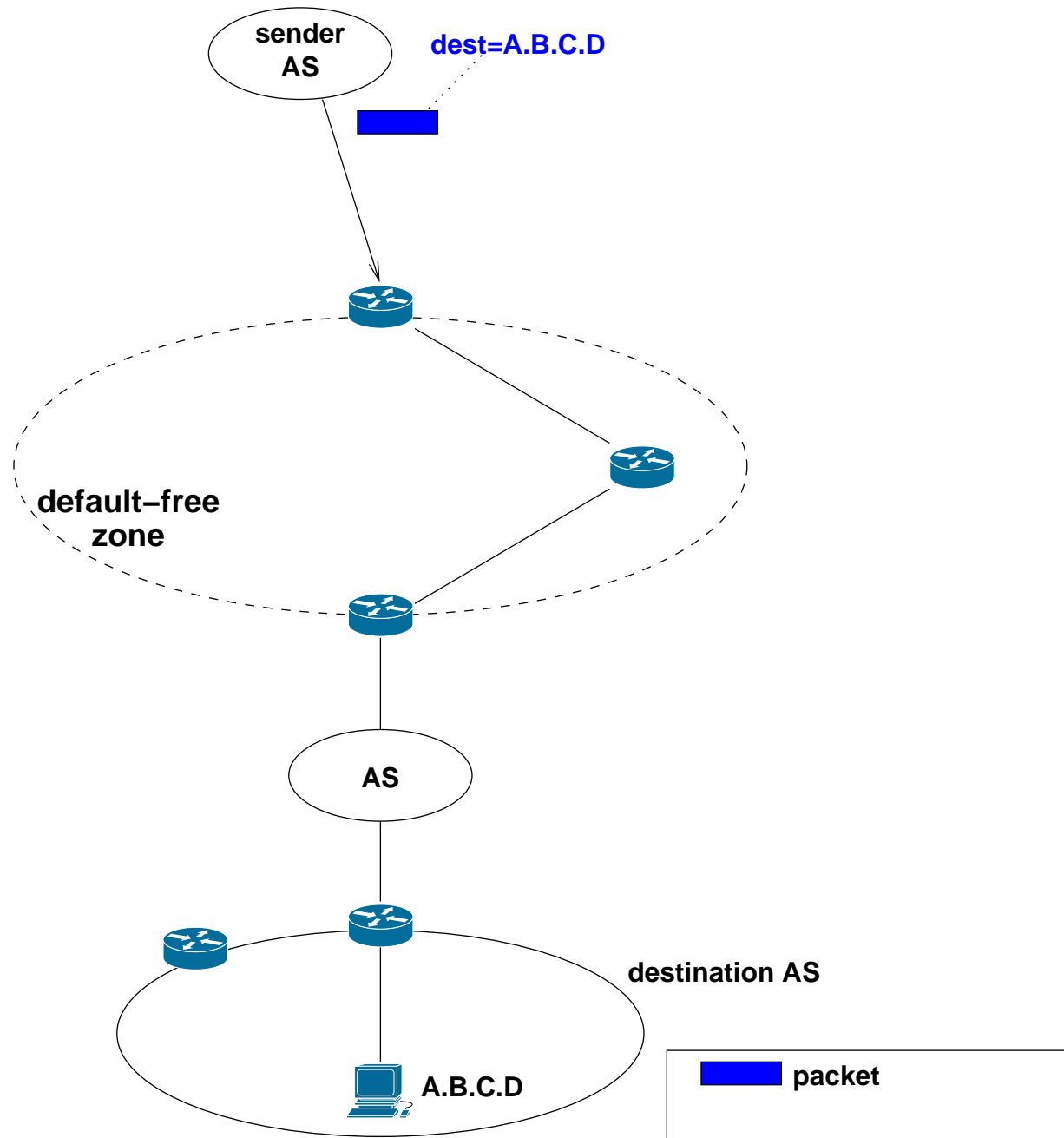
Membership technically not a routing protocol:

- No routing computations
- Location-independent (compare DNS)
- Future optimisation: separate protocol

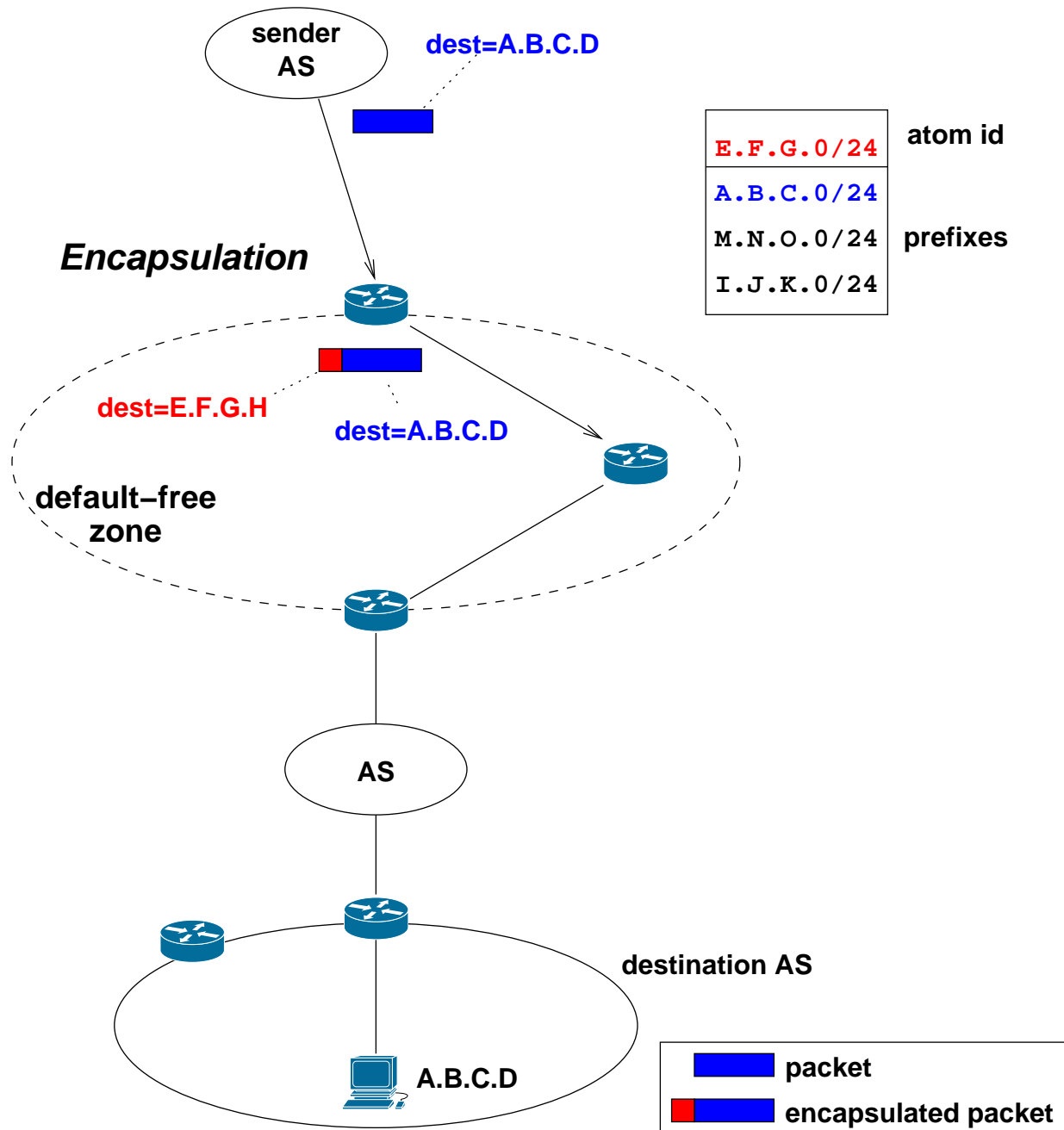
# Architecture — Overview of routing



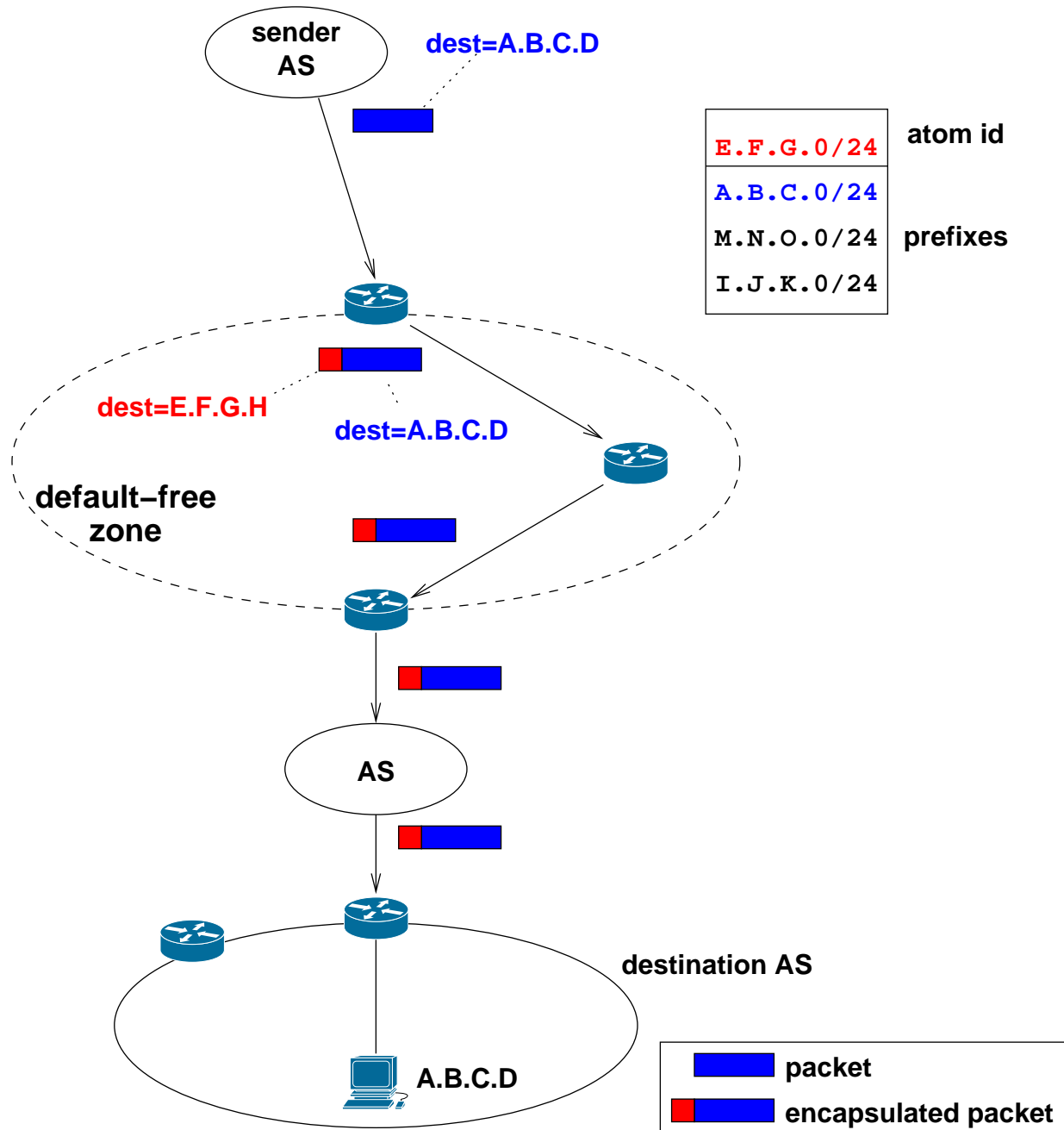
# Architecture — Overview of forwarding



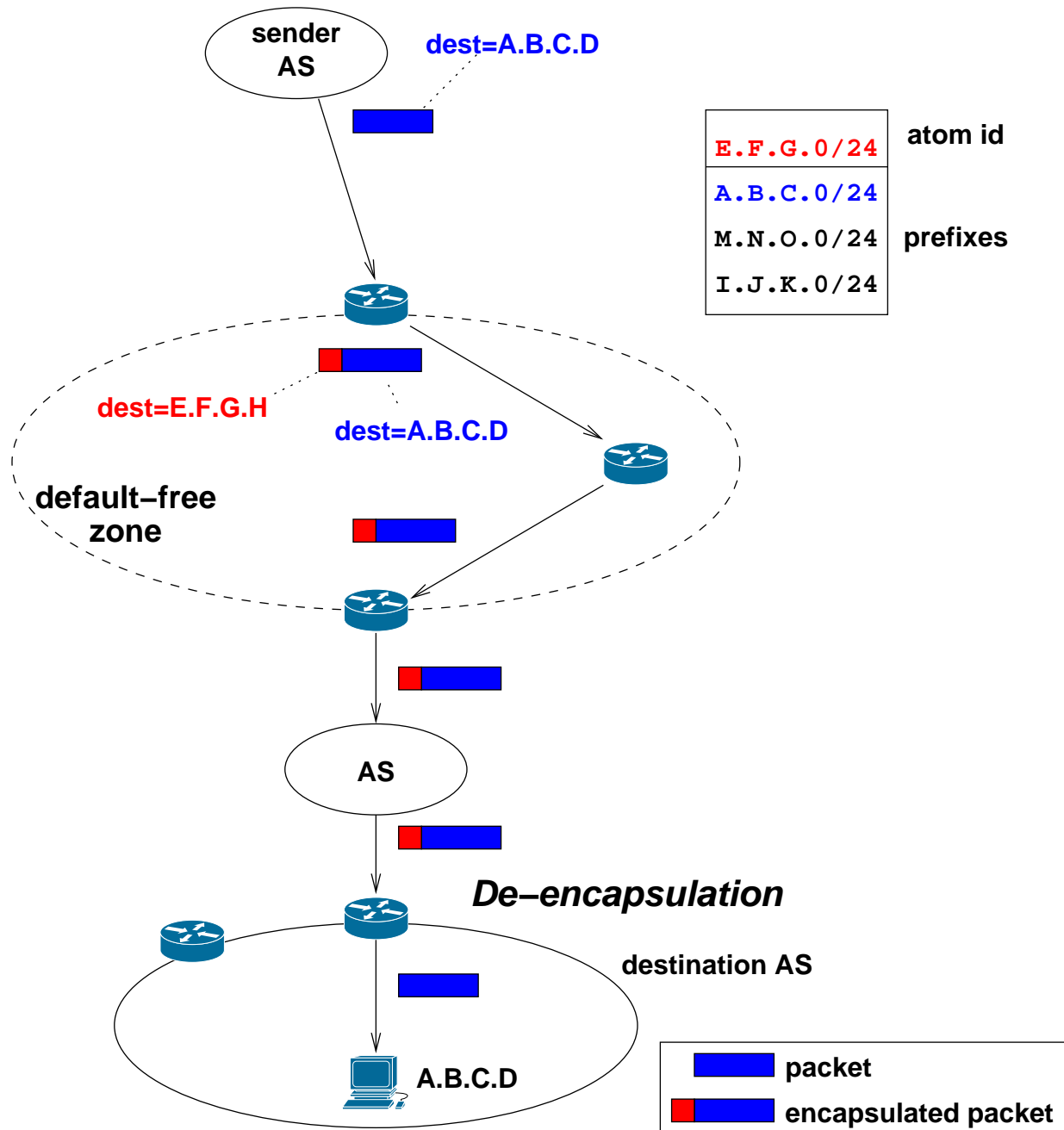
# Architecture — Overview of forwarding



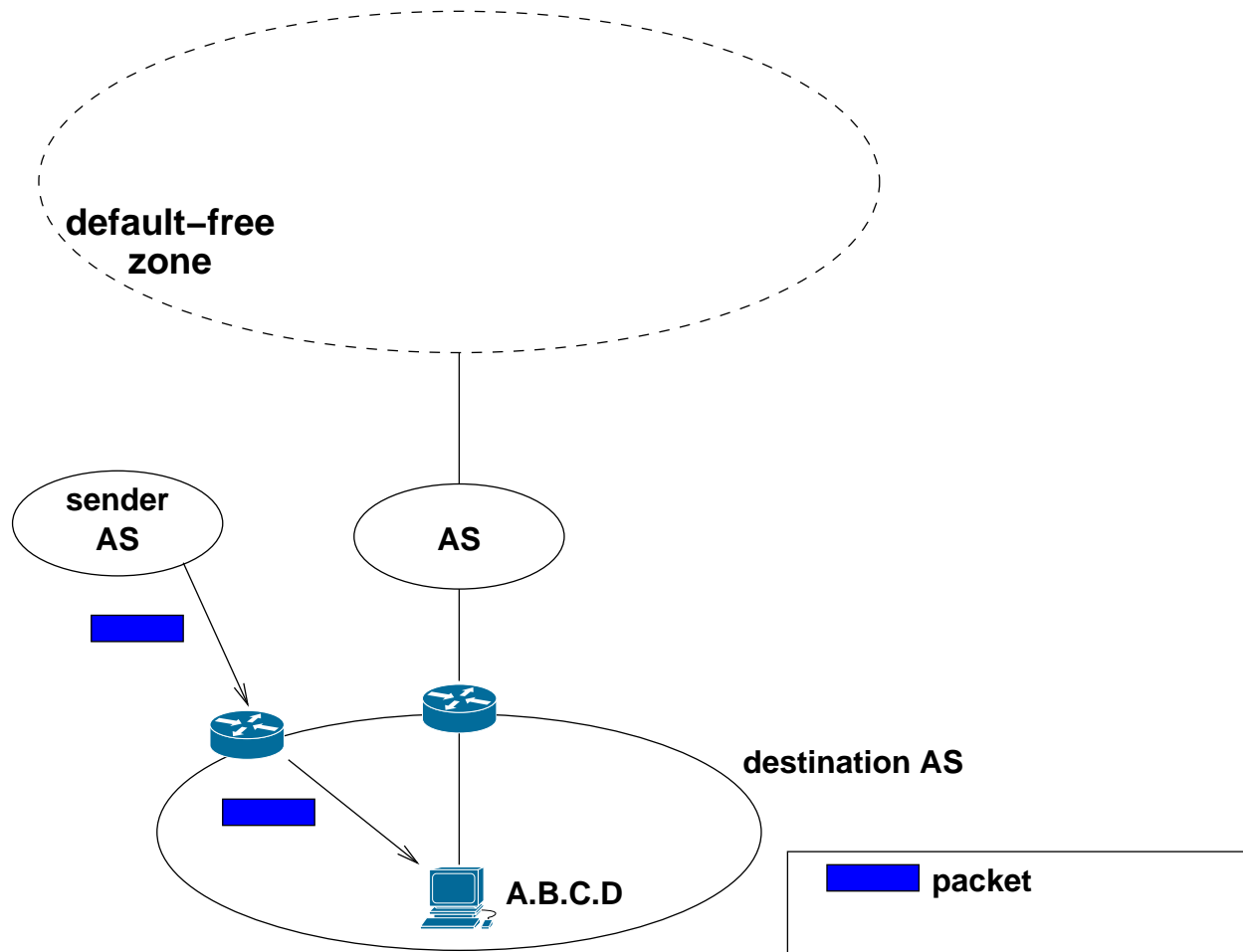
# Architecture — Overview of forwarding



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# Architecture — Overview of forwarding

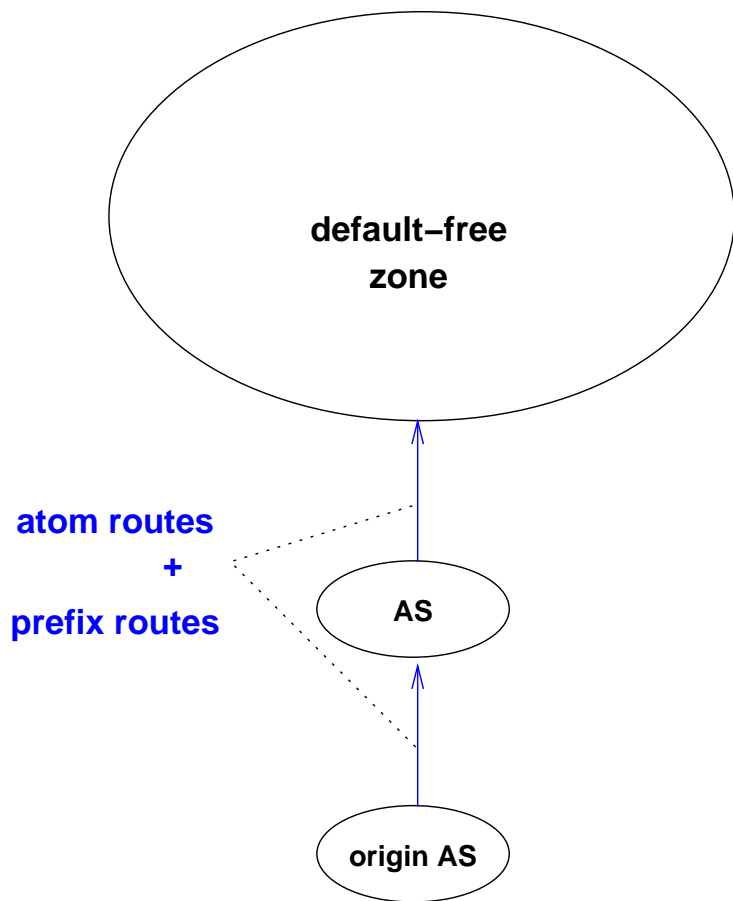


## Architecture — Overview of forwarding

Comparing atom-based forwarding and MPLS:

- Atom ID similar to Forwarding Equivalence Class
- Encapsulation rather than label swapping
- MPLS not applied interdomain

# Architecture — Routing outside DFZ



Announce atom

Withdraw	
Announce	atom ID
Membership attribute	prefixes

Announce prefixes

Withdraw	
Announce	prefixes
Membership attribute	"atomised"

Withdraw atom

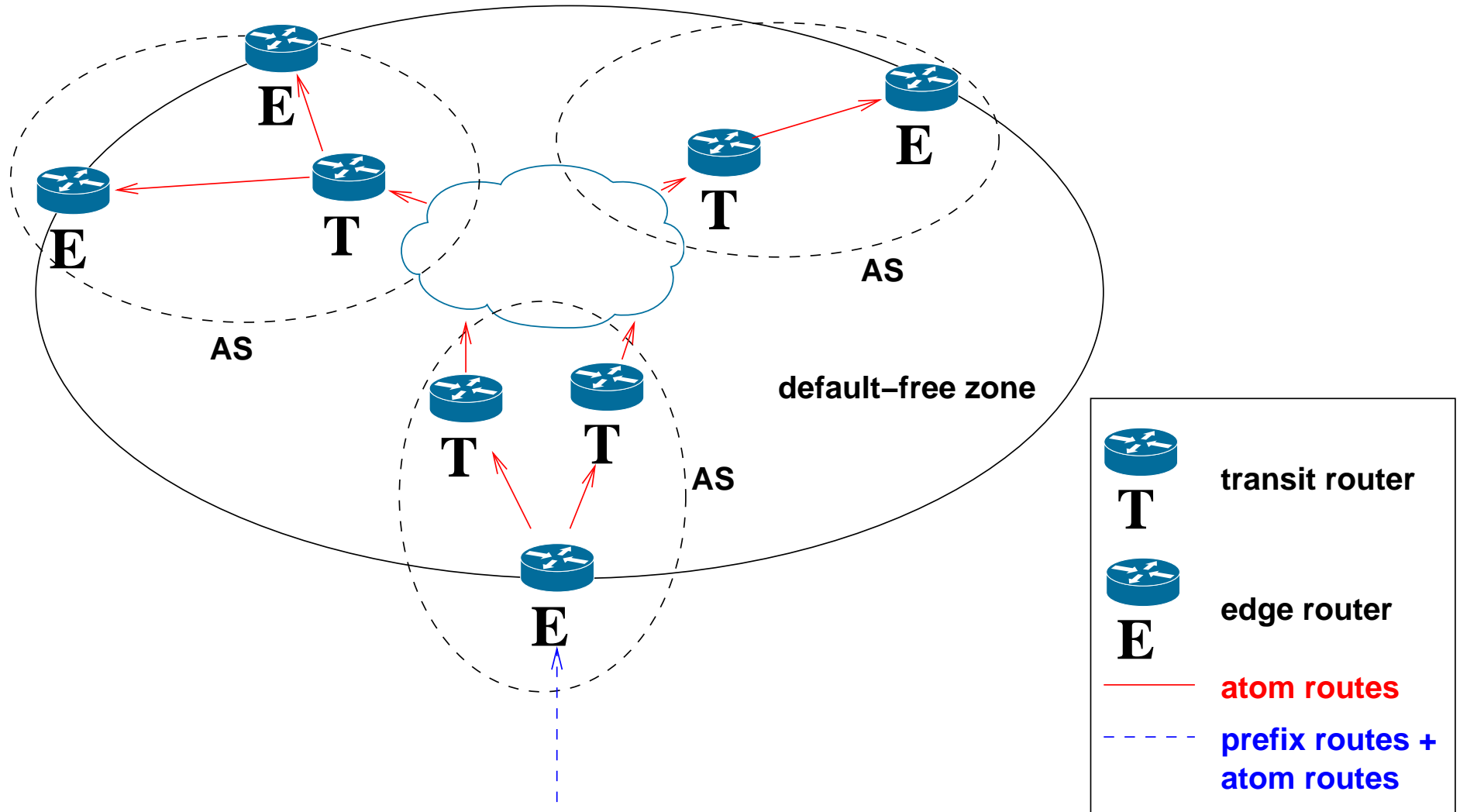
Withdraw	atom ID
Announce	
Membership attribute	

Withdraw prefixes

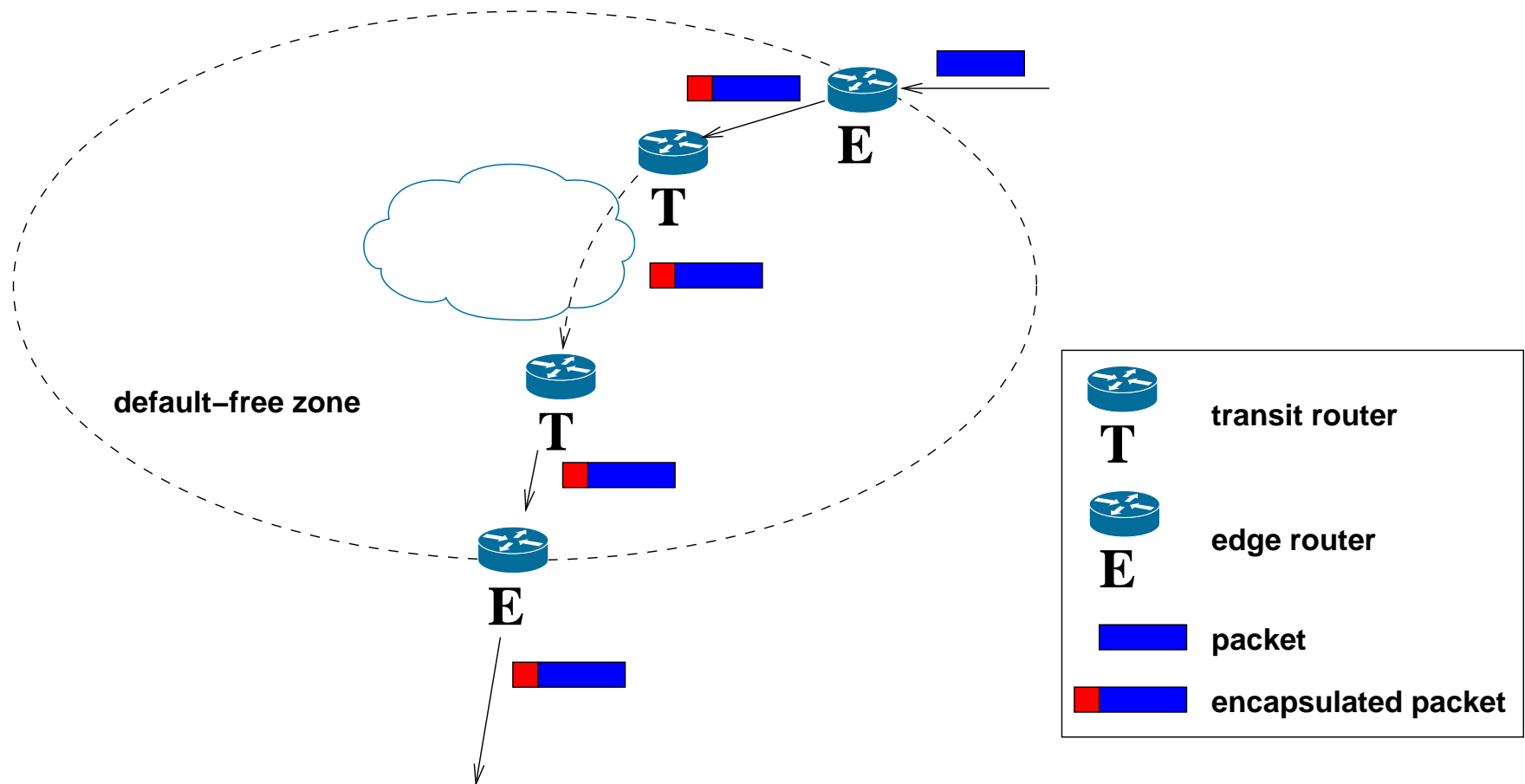
Withdraw	prefixes
Announce	
Membership attribute	

- Atom announcement carries prefix membership in attribute
- Prefixes also routed separately

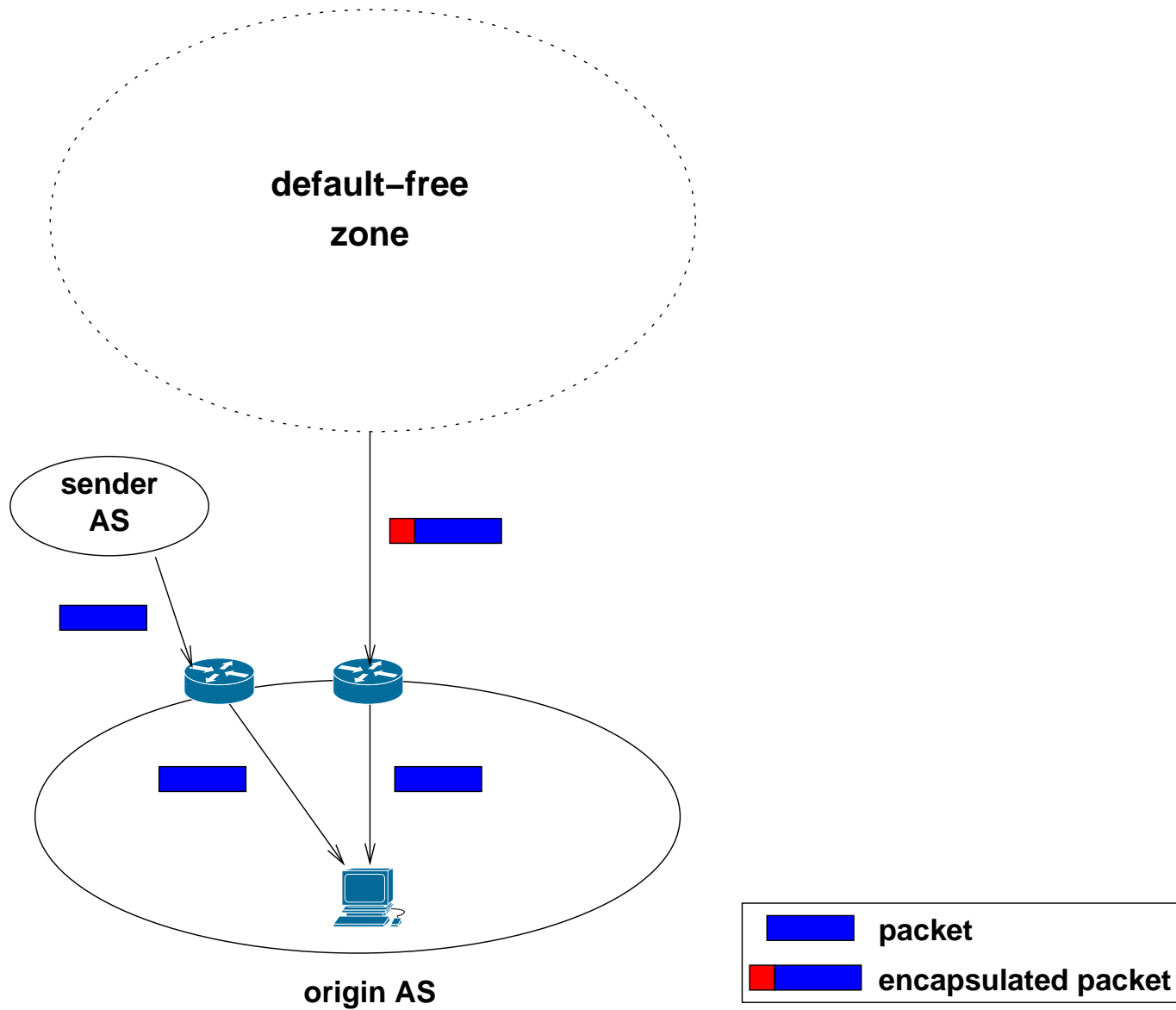
# Architecture — Routing inside DFZ



# Architecture — Forwarding inside DFZ



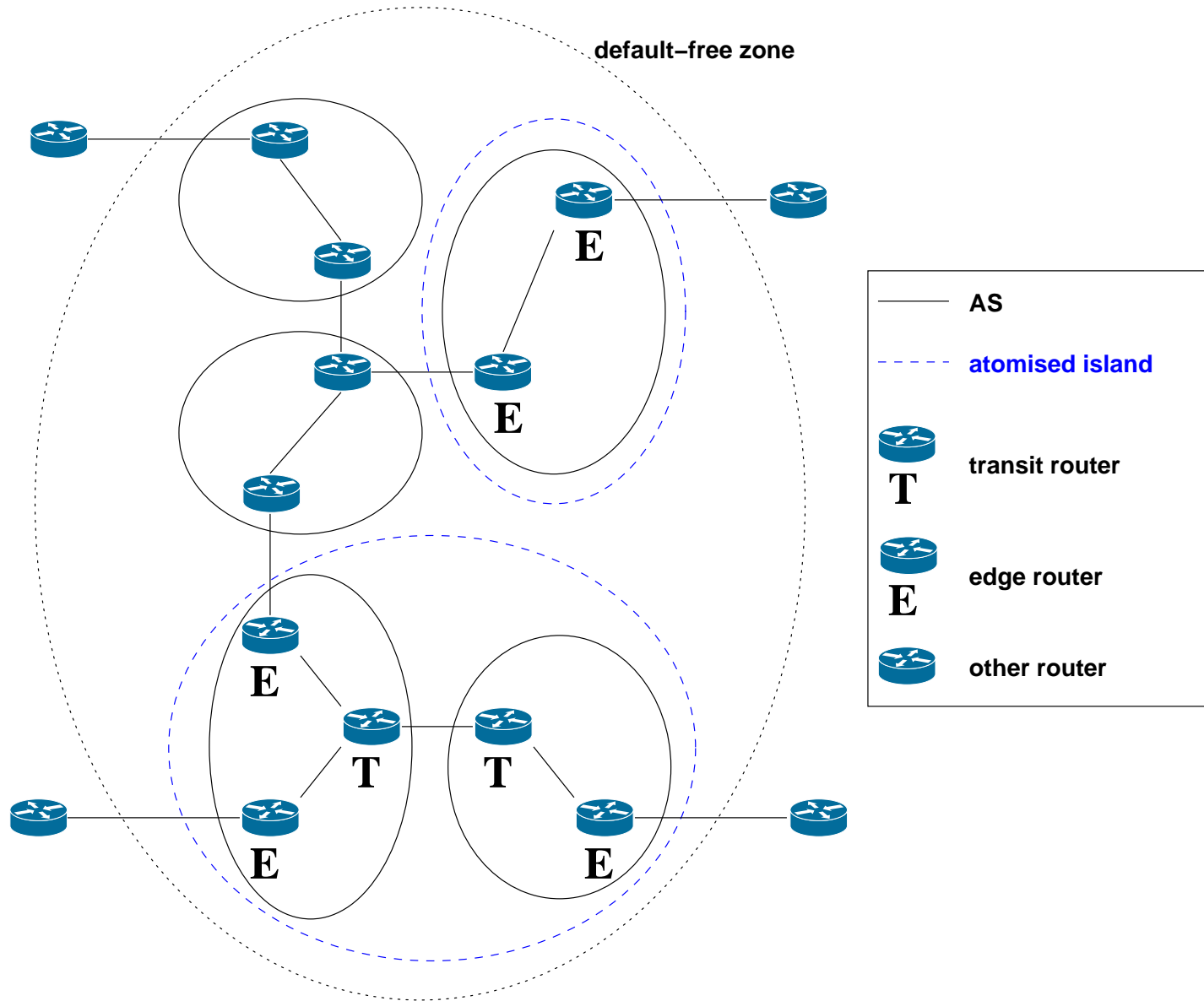
# Architecture — Forwarding outside DFZ



## Incremental deployment

- Atomless prefixes
- ASes outside DFZ that are not atomised:
  - Nothing special happens between origin AS and DFZ
  - Forwarding is transparent
  - BGP attributes are *optional transitive*
- DFZ ASes that are not atomised: islands

# Incremental deployment — Islands



## Implementation

Status of implementation:

- Implemented previous architecture of atomised routing:
  - No notion of default-free zone
  - All routers prefix-aware
  - Implementing new architecture (fall 2003)
- In Zebra: free routing software (GNU license)
- Atoms declared using router configuration language

## TODO

- A DFZ membership protocol
- Look at non-AS path policies
- Declare atoms upstream from origin AS
- Failures that force atom redeclaration

# Questions?

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<http://www.caida.org/projects/routing/atoms/>

# Architecture — Overview of forwarding

