THE GEOMORPHIC VIEW OF NETWORKING: A NETWORK MODEL AND ITS USES

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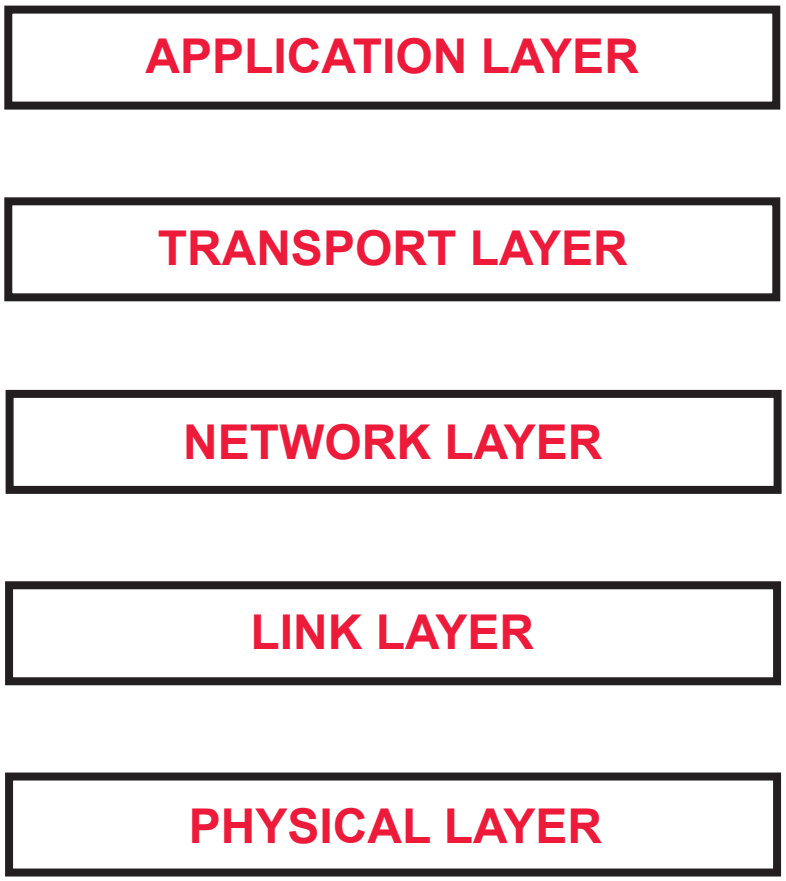
THE "CLASSIC" INTERNET ARCHITECTURE

this architecture has succeeded (beyond most peoples' wildest dreams) in fostering innovation and shaping the world we live in

however, it is now widely agreed that it does not meet society's present and future requirements

- *security*
- *dependability*
- *mobility*
- *scalability*
- *quality of service*
- *resource management*

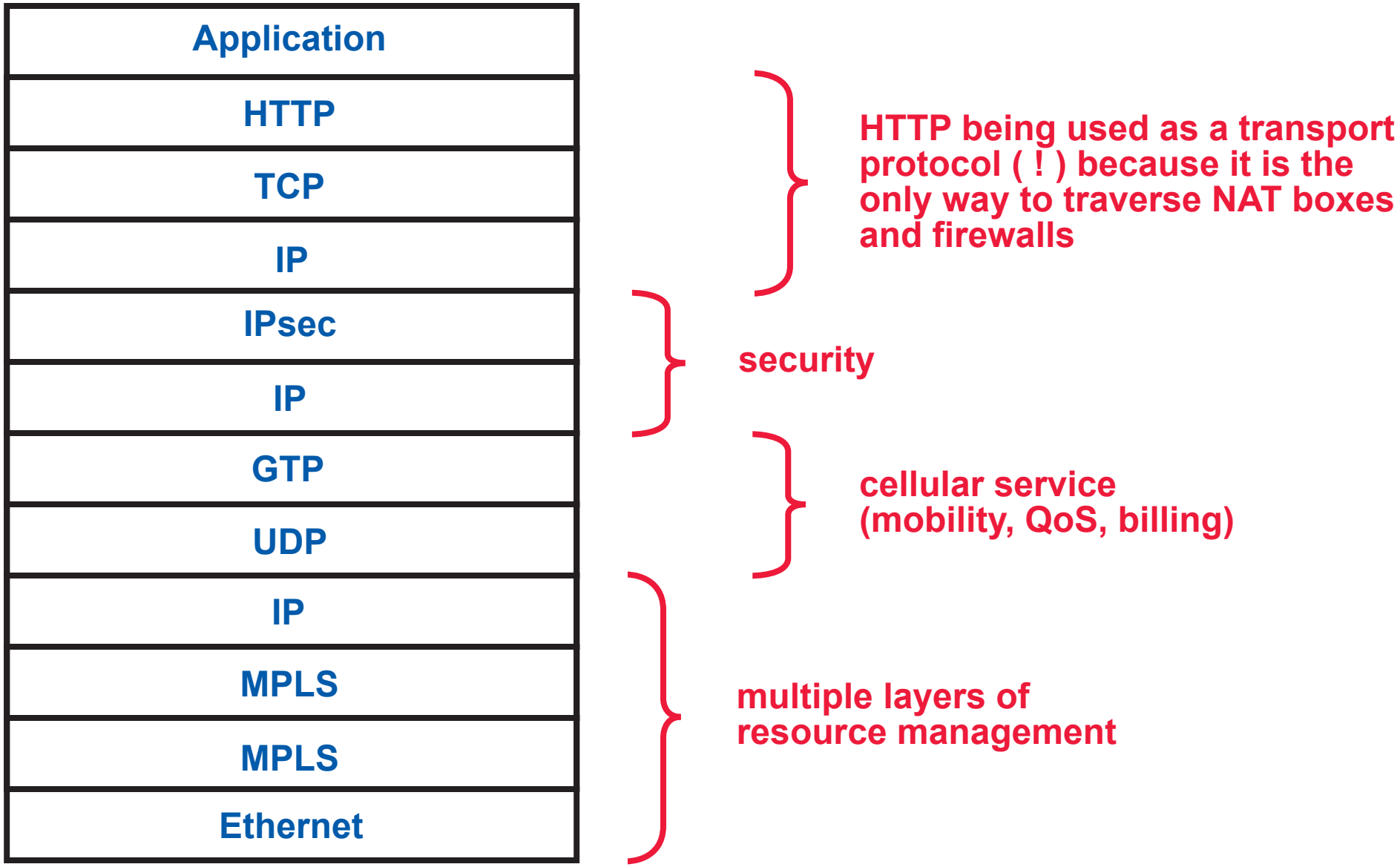


the trend is toward a more pluralistic architecture . . .

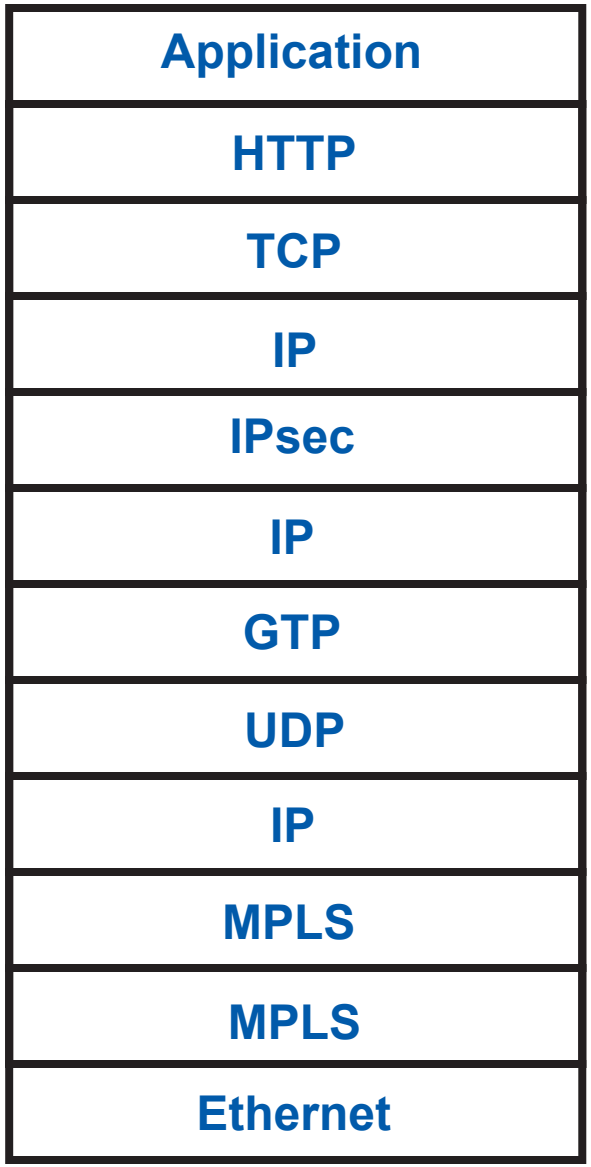
. . . with multiple, customized protocol stacks

A REAL EXAMPLE

headers in a typical AT&T packet (12 instead of 4)



A REAL EXAMPLE: WHAT ARE THE PROBLEMS?



COMMUNICATION SERVICES

we need . . .

- a broader range of services
- security appropriate to each application

. . . so that all applications can be developed easily and efficiently

DESIGN PRINCIPLES

this is not the most efficient way to satisfy the stakeholders' requirements!

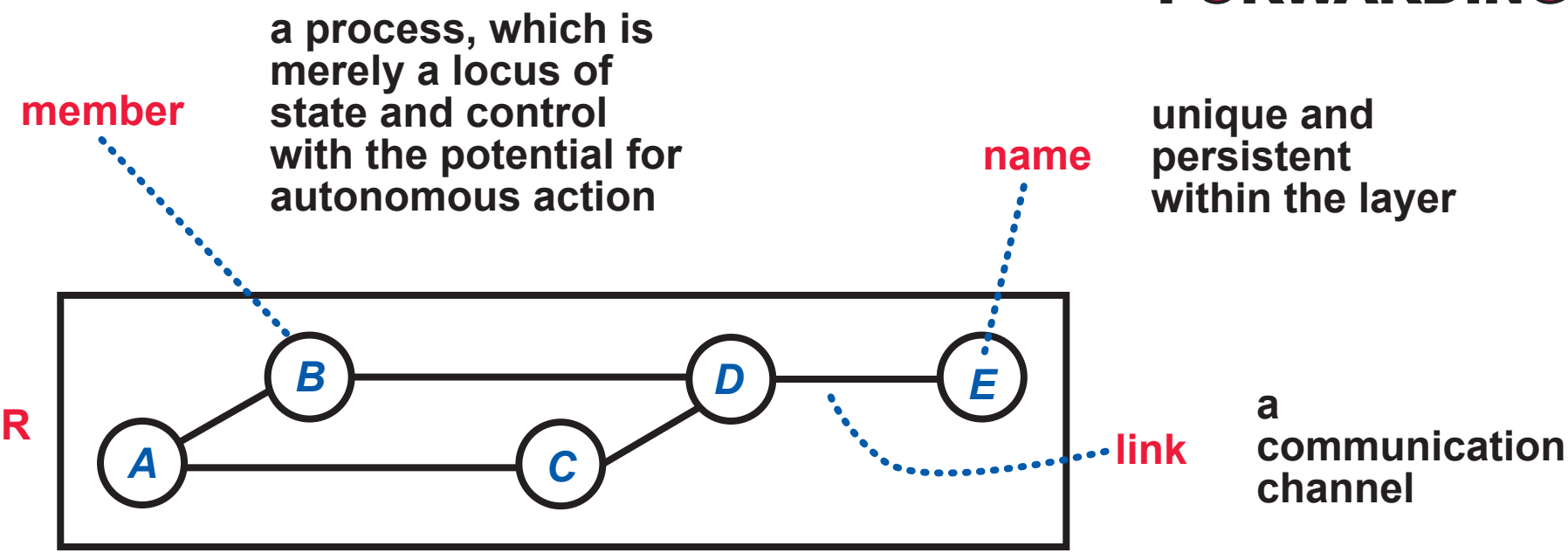
15 load-balancing algorithms apply to each packet; each designed and analyzed in isolation

we need principles that apply to all levels, produce modular and predictable behavior

SOFTWARE DEVELOPMENT

we need to develop all this custom software through code re-use and code generation

A NEW LAYER MODEL: MEMBERS, ROUTING, AND FORWARDING



forwarding protocol enables members to send messages to one another, using the links

routes often there is not a link between every pair of members; routes tell the forwarding protocol how to reach one member from another over the existing links, with forwarding by intermediate members

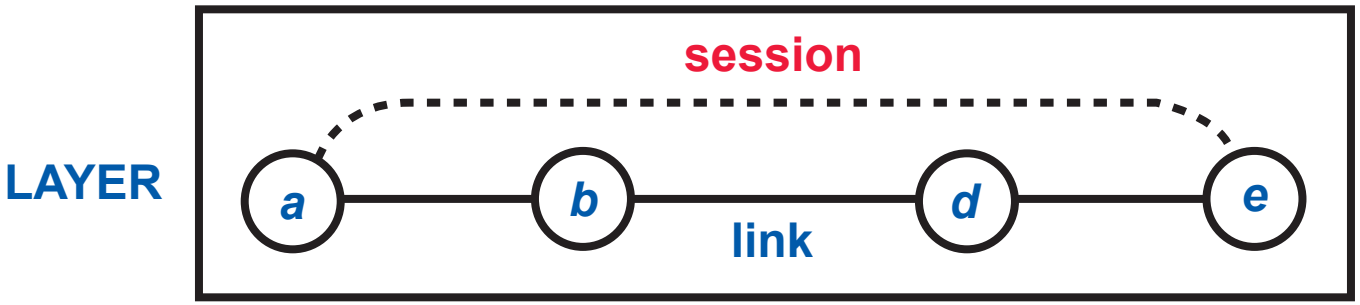
routing algorithm maintains the routes as links change over time

A NEW LAYER MODEL: COMMUNICATION SERVICES

channel an instance of a communication service

session a communication channel (as are links)

session protocol implements an end-to-end communication service, on top of the basic, fundamentally unreliable, message delivery provided by the forwarding protocol



from the perspective of one layer, sessions are more convenient than links

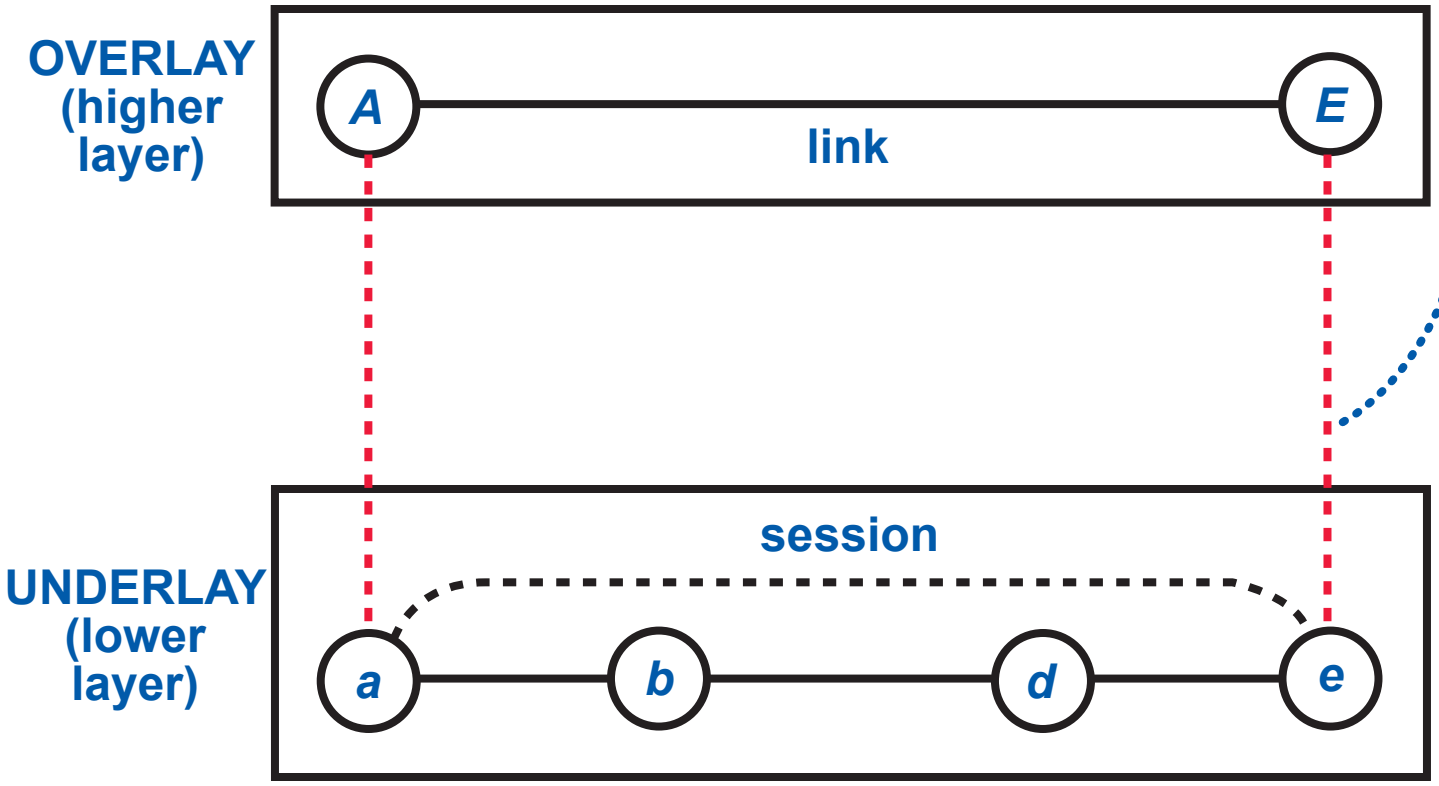
they have longer reach; might be more reliable, better-behaved (with FIFO delivery), with guaranteed performance, *etc.*

A NEW LAYER MODEL: THE "USES" HIERARCHY

when an overlay uses an underlay, a link in the overlay is implemented by a session in the underlay

registration

relates an overlay member to the underlay member that it is using on the same machine



to set up this link/session:

1. *A* sends request to *a*
2. *a* looks up registration of *E*, finds *e*
3. *a* sends request to *e*
4. *e* sends request to *E*

A NEW LAYER MODEL: THE MAJOR COMPONENTS

PROTOCOLS

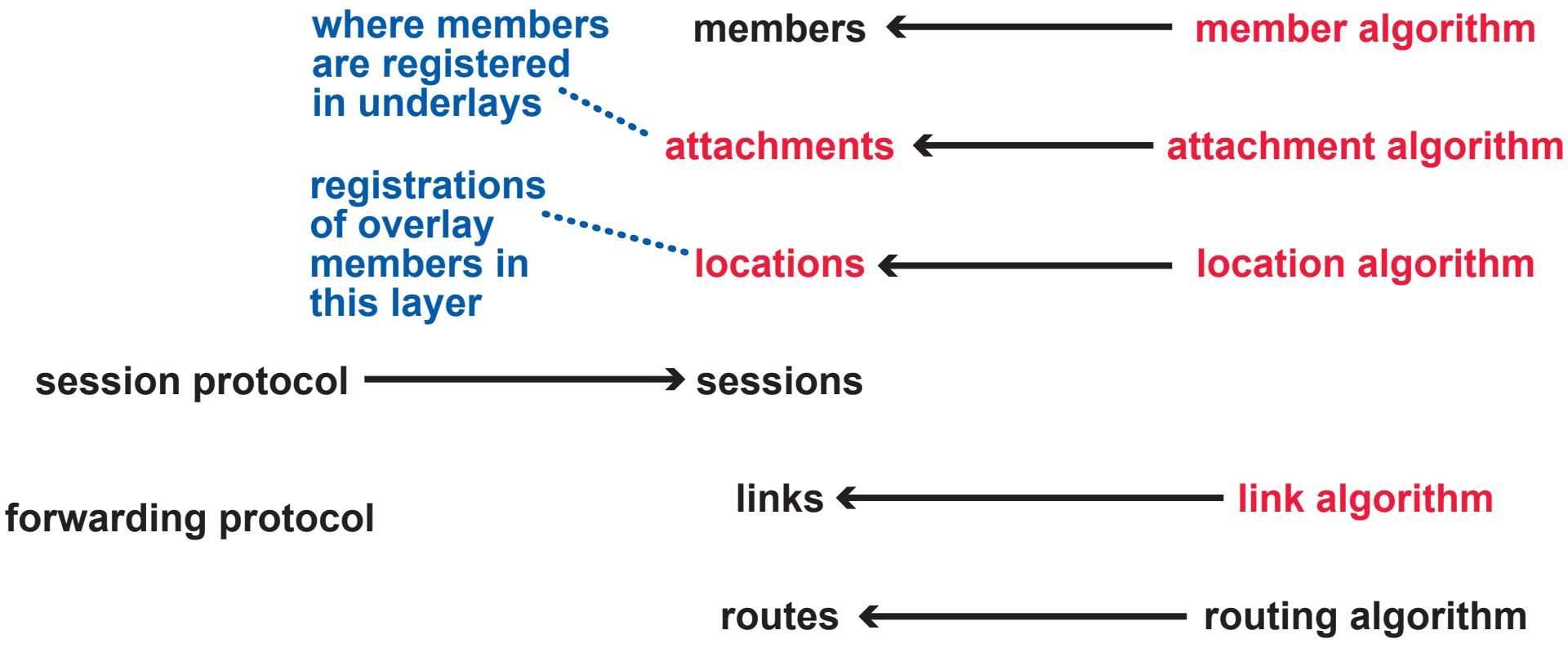
every member must participate

STATE

can be centralized or distributed across the members in any way

ALGORITHMS

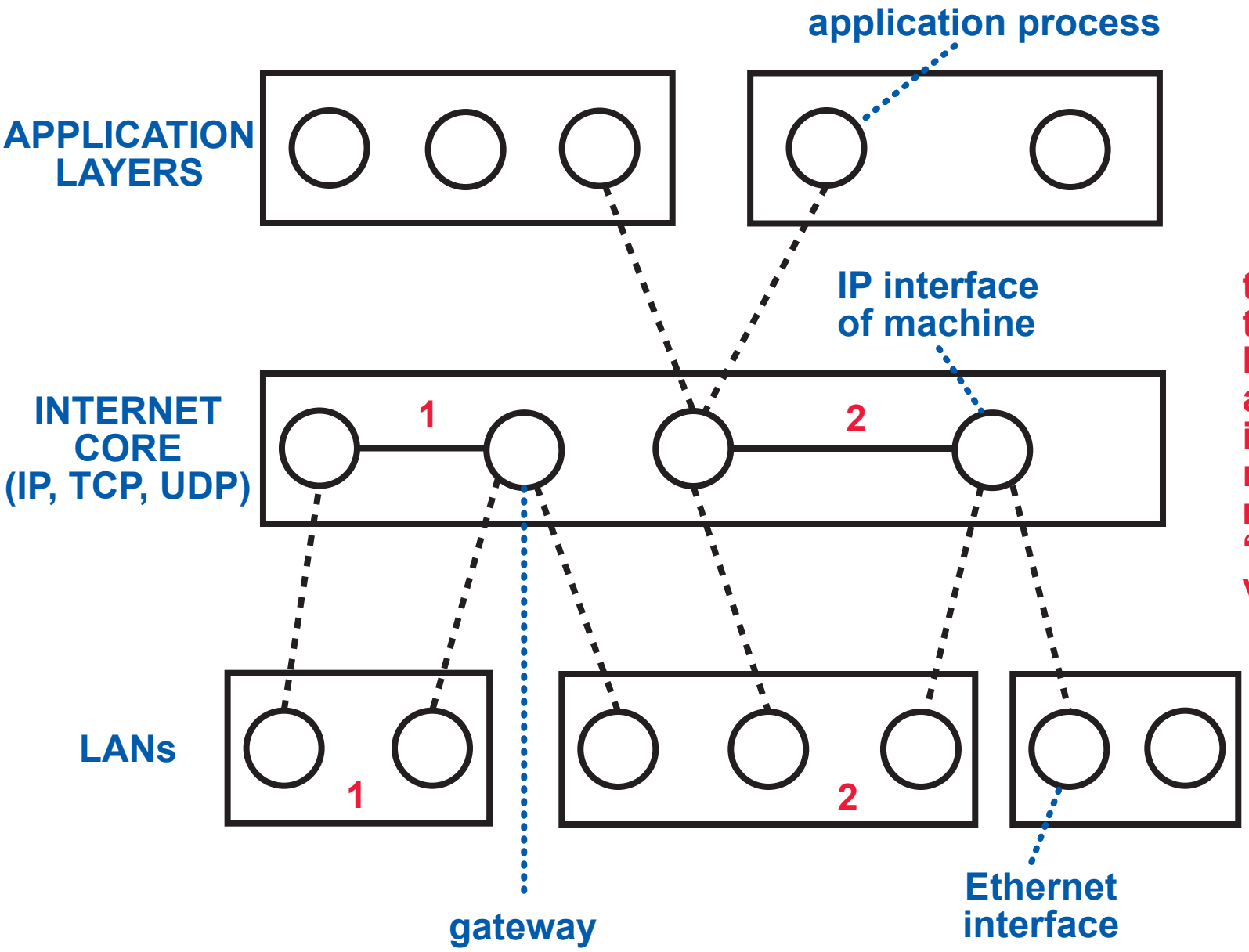
can be centralized or distributed across the members in any way



A NEW LAYER MODEL: SCOPE AND LEVEL

layers are arranged in a "uses" hierarchy, which defines levels

the scope of a layer is the set or class of processes that could be members



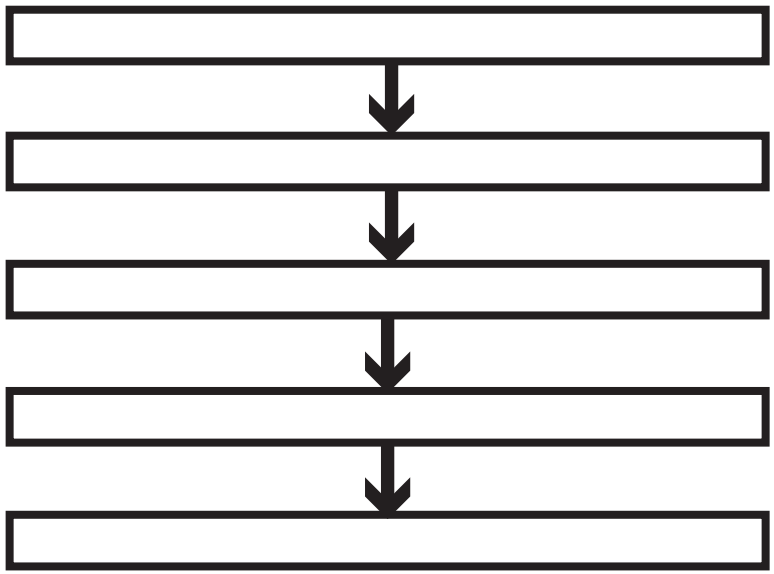
this describes the classic Internet architecture in terms of the new layer model or "geomorphic view"

CLASSIC LAYERS OR OSI REFERENCE MODEL

there is a fixed number of levels

the scope of each layer is global, so layer = level

each layer/level has a specialized function

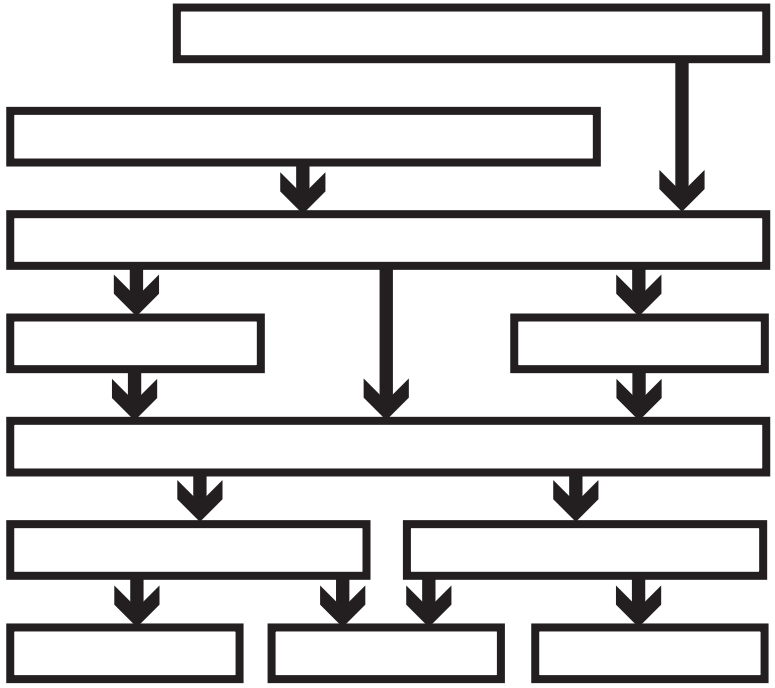


THE GEOMORPHIC VIEW OF NETWORKING

there can be any number of levels

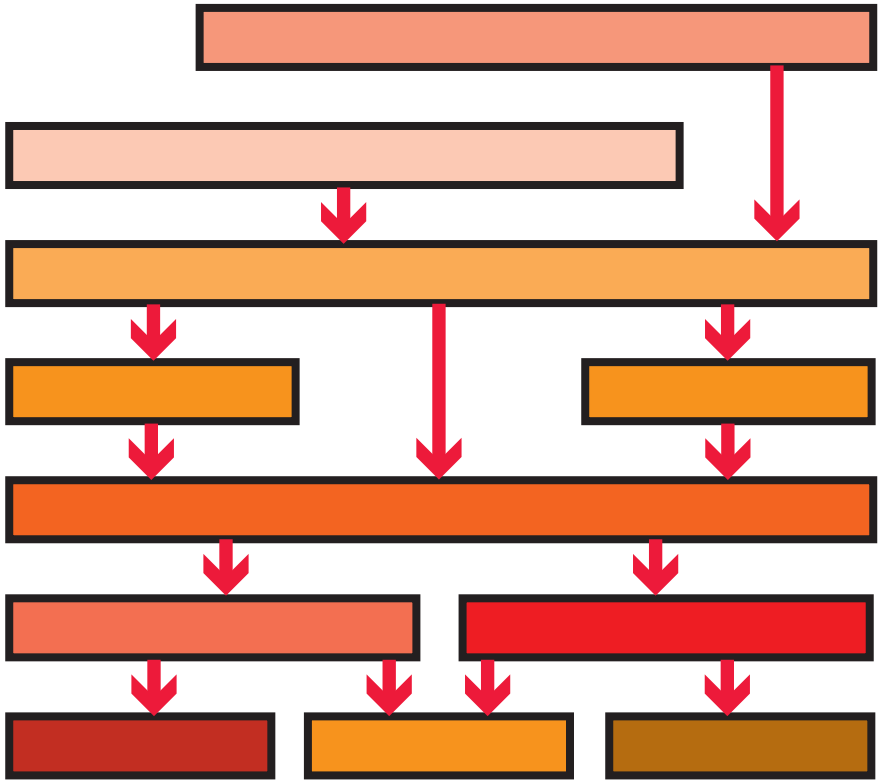
some layers have small or local scopes

each layer is a microcosm of networking, containing all the basic components (state components and mechanisms)



WE CALL THIS THE "GEOMORPHIC VIEW" OF NETWORKING . . .

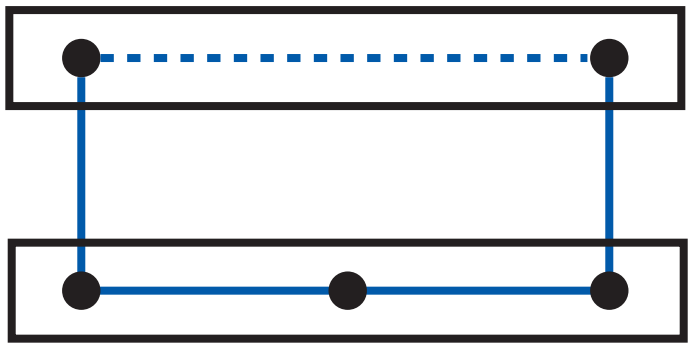
. . . BECAUSE THE COMPLEX ARRANGEMENT OF LAYERS RESEMBLES THE EARTH'S CRUST



HOW CAN THE GEOMORPHIC VIEW HELP? SIMPLICITY

NO MORE TUNNELS

the *only* encapsulation is inter-layer encapsulation



NO MORE ARGUING ABOUT NAMES vs. IDENTIFIERS vs. LOCATORS vs. ADDRESSES

each layer has exactly one name space, designed for the purposes of the layer (whatever you wish to call the names)

the goal is to describe architectures with fewer, better-understood mechanisms . . .

. . . rather than many *ad hoc* mechanisms whose interactions we do not understand

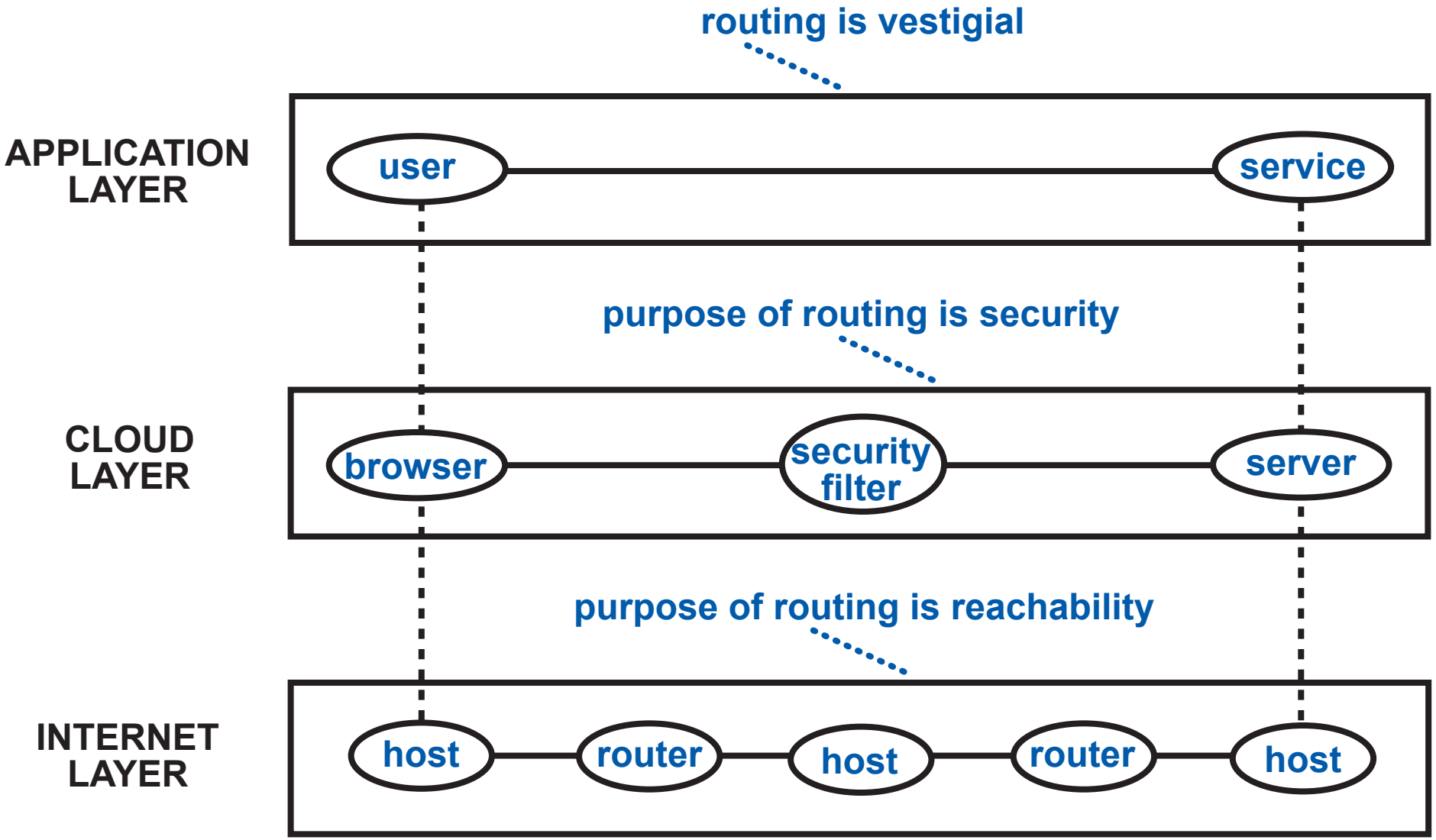
hopefully, there will be no constraints on which architectures can be described

HOW CAN THE GEOMORPHIC VIEW HELP?

GENERALIZATION

the same basic mechanism
is used for different purposes
in different layers . . .

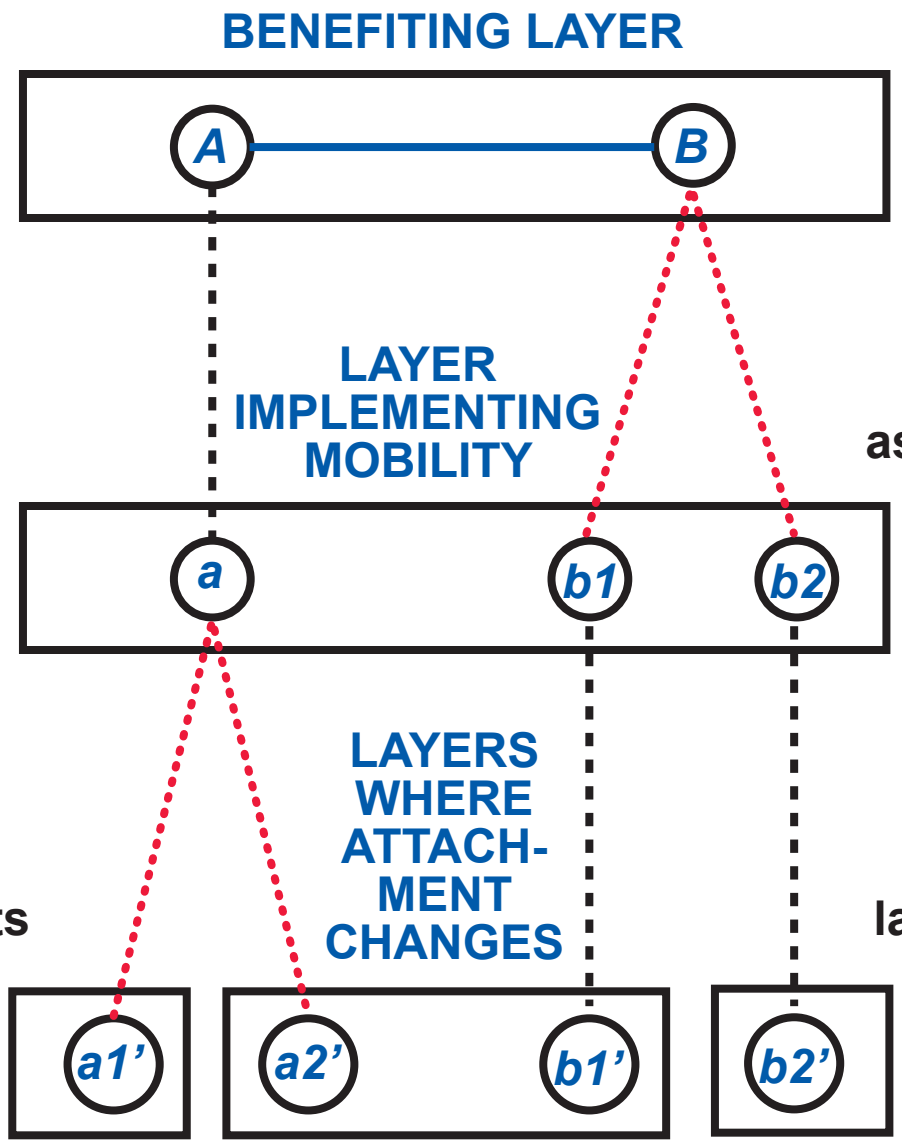
. . . so all layers can
benefit from the same general
theories and possibly even implementations



HOW CAN THE GEOMORPHIC VIEW HELP?

UNDERSTANDING

THERE ARE TWO DISTINCT PATTERNS FOR MOBILITY ····· a discovery enabled by the geomorphic view



DYNAMIC ROUTING MOBILITY

as the attachments of a member change, its links change, and the routing algorithm must find new routes to it

layer state components that change:

- *attachments*
- *links*
- *routes*

SESSION-LOCATION MOBILITY

as the session endpoint in the overlay changes its location in this layer, the session state changes to match it

layer state components that change:

- *locations*
- *sessions*

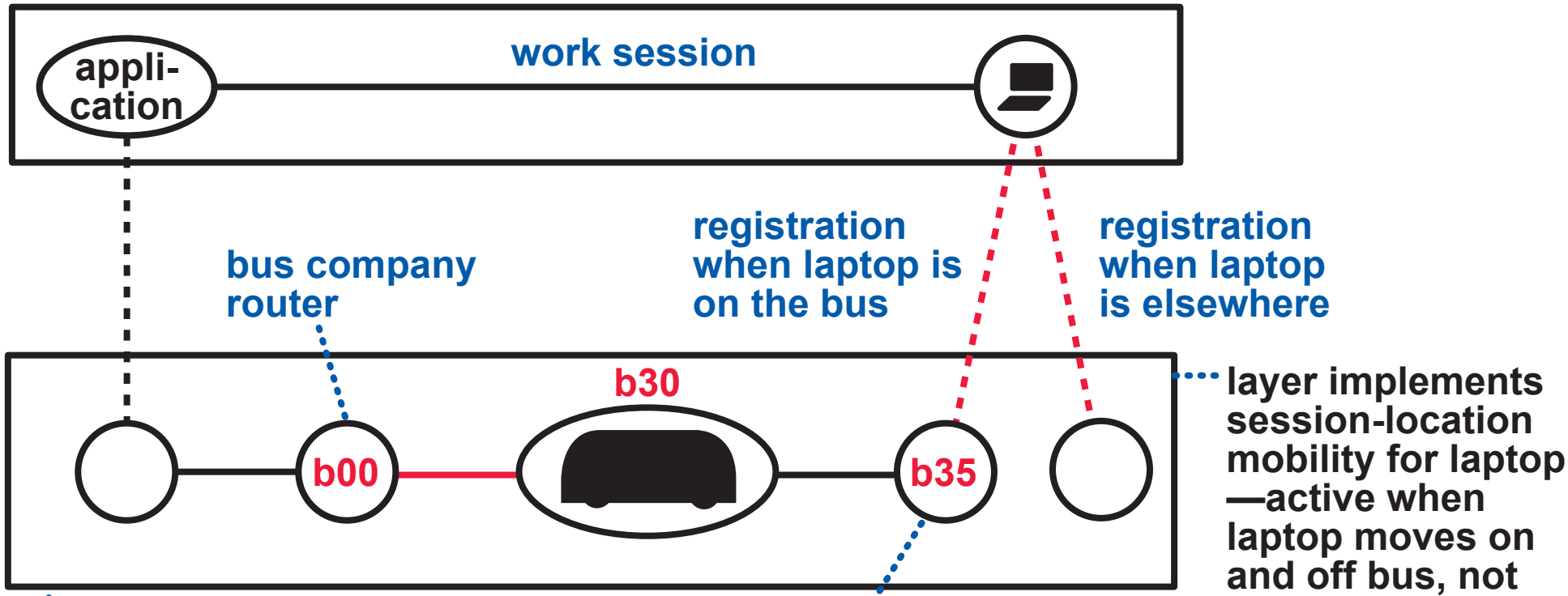
HOW CAN THE GEOMORPHIC VIEW HELP?

DESIGN COMPARISON

A DESIGN HAS ONLY ONE CORRECT DESCRIPTION

AN ORGANIZED SPACE OF POSSIBLE DESIGNS CAN BE GENERATED

picture shows a scalable design for mobility of routers as well as endpoints (a previously unsolved problem) generated within a mobility design space



HOW CAN THE GEOMORPHIC VIEW HELP?

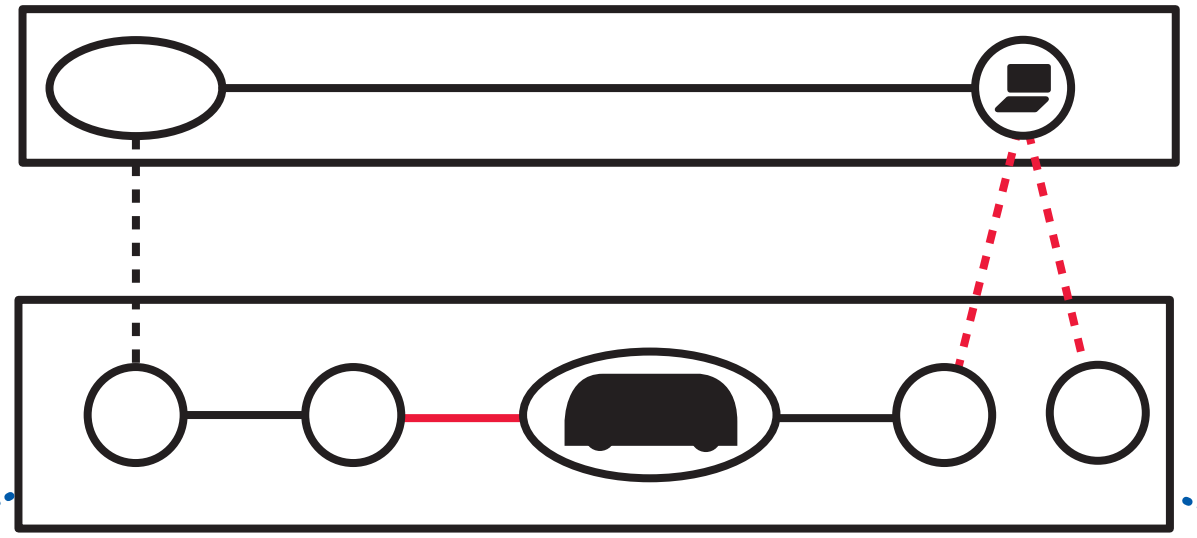
FORMALIZATION

WE HAVE A FORMAL MODEL OF LAYERS AND LAYER COMPOSITION (the "uses" hierarchy) IN ALLOY

this model becomes more complete as we use it to investigate more issues

FOR EXAMPLE, WE HAVE A COMPLETE MODEL OF DYNAMIC ROUTING AND SESSION-LOCATION MOBILITY

this model has been used to prove that dynamic routing and session-location mobility are compositional within a layer: they co-exist and work without interference



layer implements dynamic routing mobility for bus

layer implements session-location mobility for laptop

SUMMARY

WE NEED MULTIPLE, CUSTOMIZED PROTOCOL STACKS WITH . . .

- better communication services
- design principles
- code generation and re-use

THE GEOMORPHIC VIEW OF NETWORKING IS A USEFUL TOOL—IT OFFERS . . .

- simplicity
- generalization
- understanding
- design comparison
- formalization

Isn't this all too low-level for middleware and service-oriented architecture?

NO! For example, mobility is everywhere you look.