Seeing The Past, Present and Future: Macro Trends in Networking and the Role of Software Defined Networking

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Agenda

- (Macro) Trends Inducing an New Landscape
- The Past: How We Got Here
- The Present: What Exactly is the Current State of Affairs?
- The Future: Where's it All Going
- Q&A if we have time

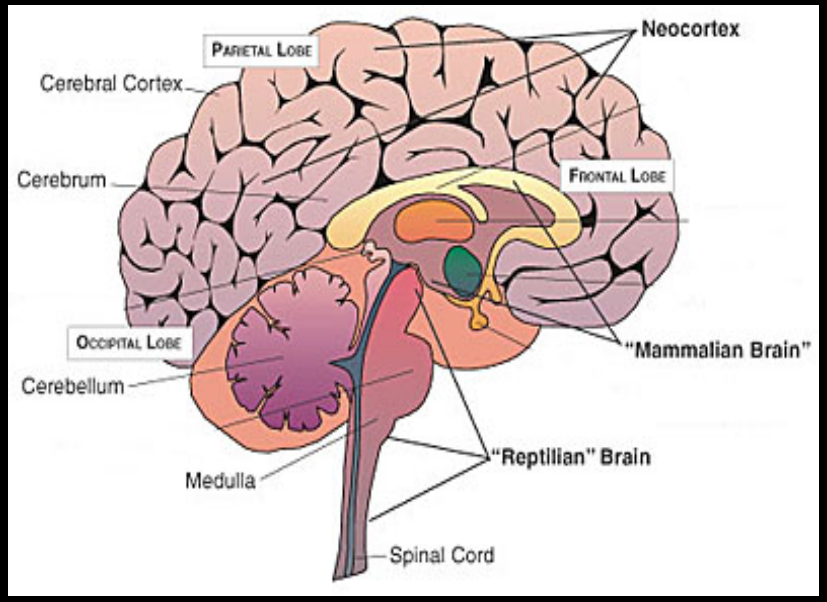
Macro Trends

The Evolution of Intelligence

Precambrian (Reptilian) Brain to Neocortex → Hardware to Software

HARDWARE

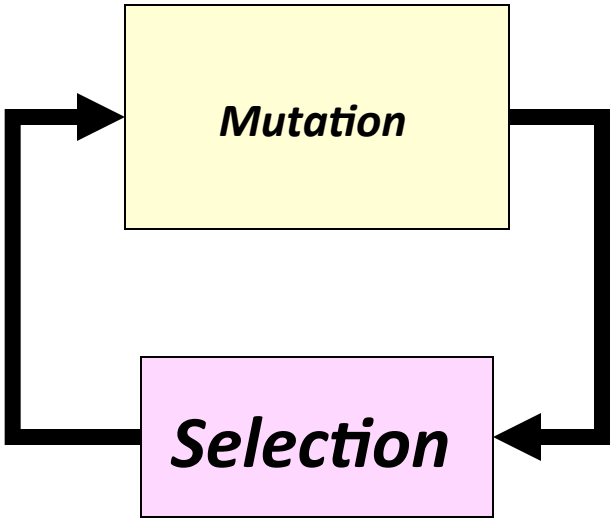
SOFTWARE



- Shared Themes/Biological Metaphors
  - Thin-waist architectures
  - Massively distributed
  - Highly layered with Robust Control loops
  - Component Reuse

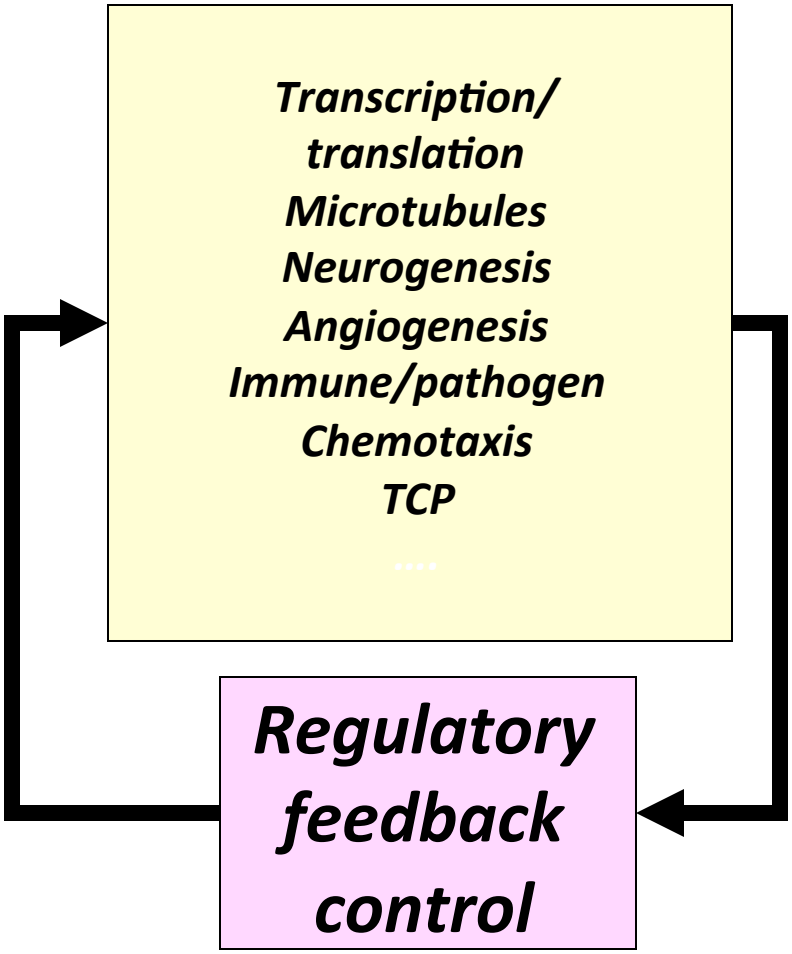
Its all about code!

BTW, there's an apparent paradox → Component behavior ***gratuitously*** uncertain, yet systems have robust performance.



Darwinian evolution uses selection on random mutations to create complexity.

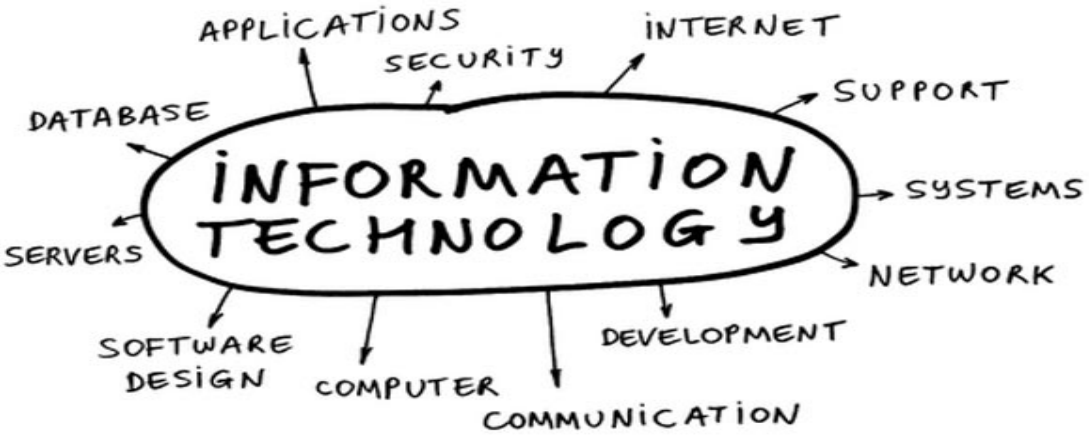
Network folks use what, exactly?



Everything De-silos

Vertical -> Horizontal Integration
Open {APIs, Protocols, Source}
Everything Pluggable
Future is about Ecosystems

Network Centric → IT Centric



- Shift in influence and speed
- Shift in locus of purchasing influence
- Changes in cost structures
  - ETSI NfV, ATIS, IETF, …
- **NetOPs → DevOPs**

Other Important Macro Trends

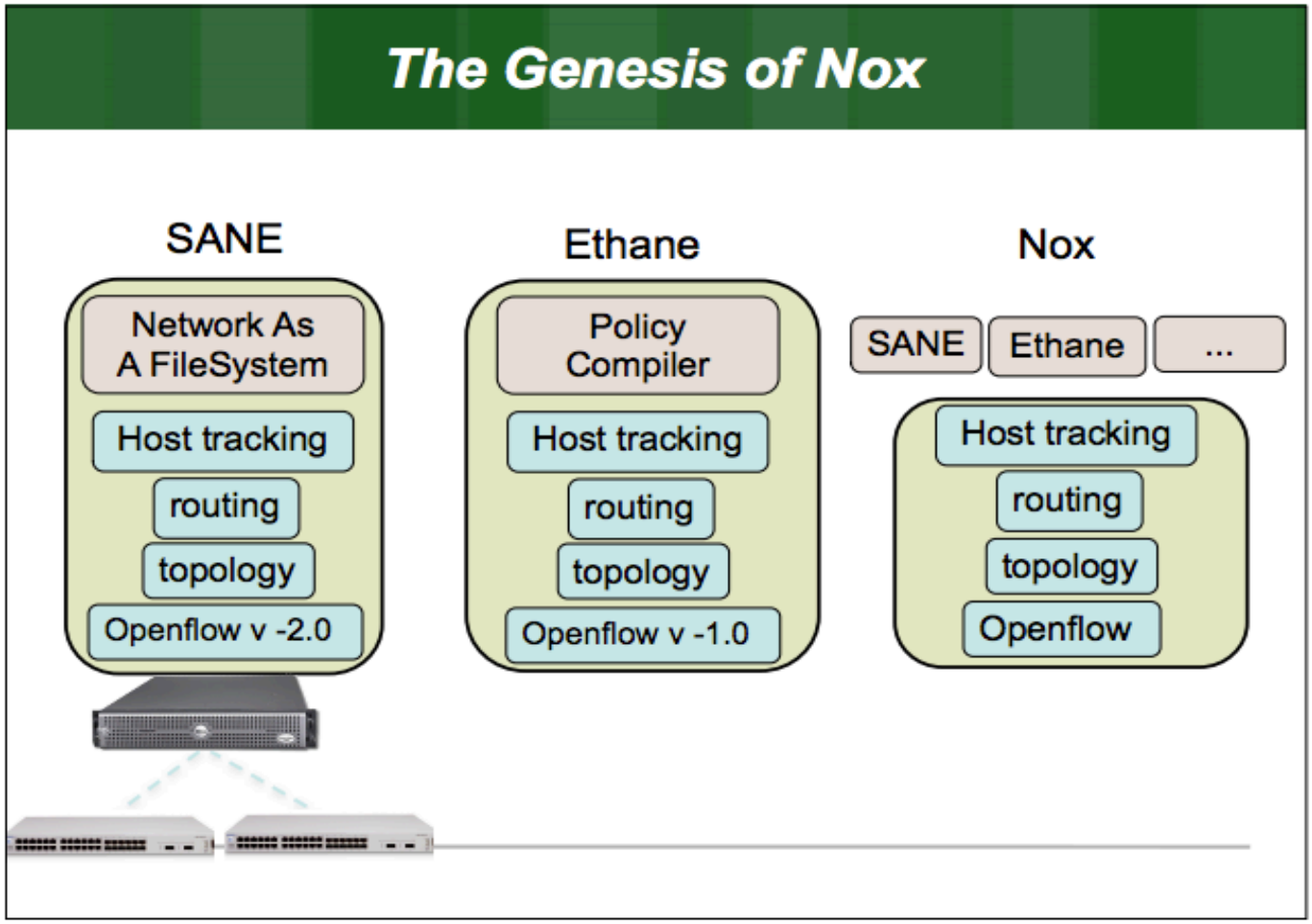
- Everything Virtualizes
  - Well, we've seen this
- Data Center new "center" of the universe
  - Looks like ~ 40% of all traffic is currently sourced/sinked in a DC
  - Dominant service delivery point
- Integrated orchestration of almost everything
- Bottom Line: Increasing influence of software *everywhere*
  - All integrated with our compute, storage, identities, …

The Past: How We Got Here

Basically, everything *networking* was to vertically integrated, tightly coupled, non-standard

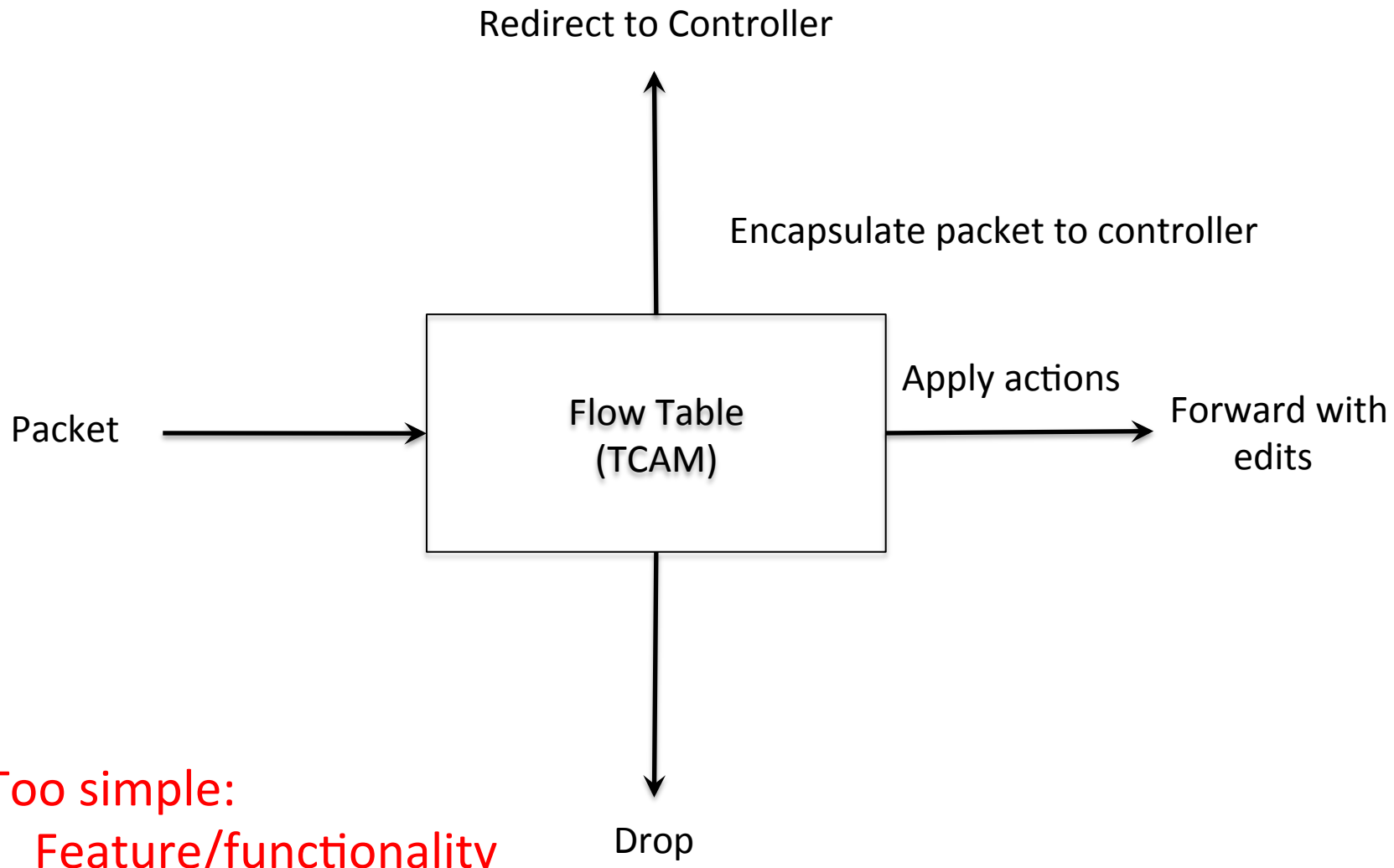
Goes without saying that this made the job of the network researcher almost impossible.
So what happened?

In the Beginning…
(in)SANE



Slide courtesy Martin Cassado

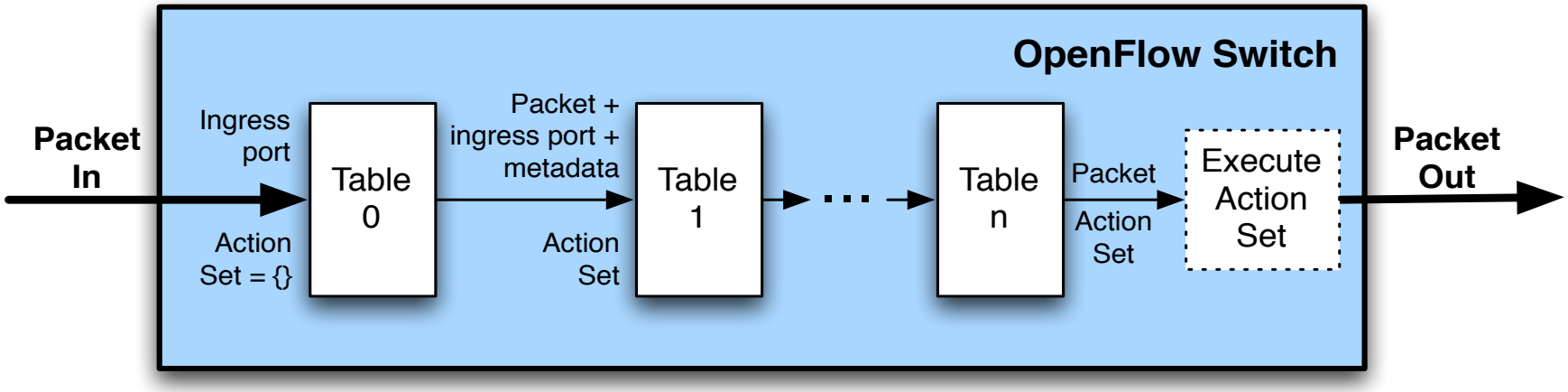
OpenFlow Switch Model Version 1.0



Too simple:

- Feature/functionality
- Expressiveness

The Present: Current (ONF) SOA



(a) Packets are matched against multiple tables in the pipeline

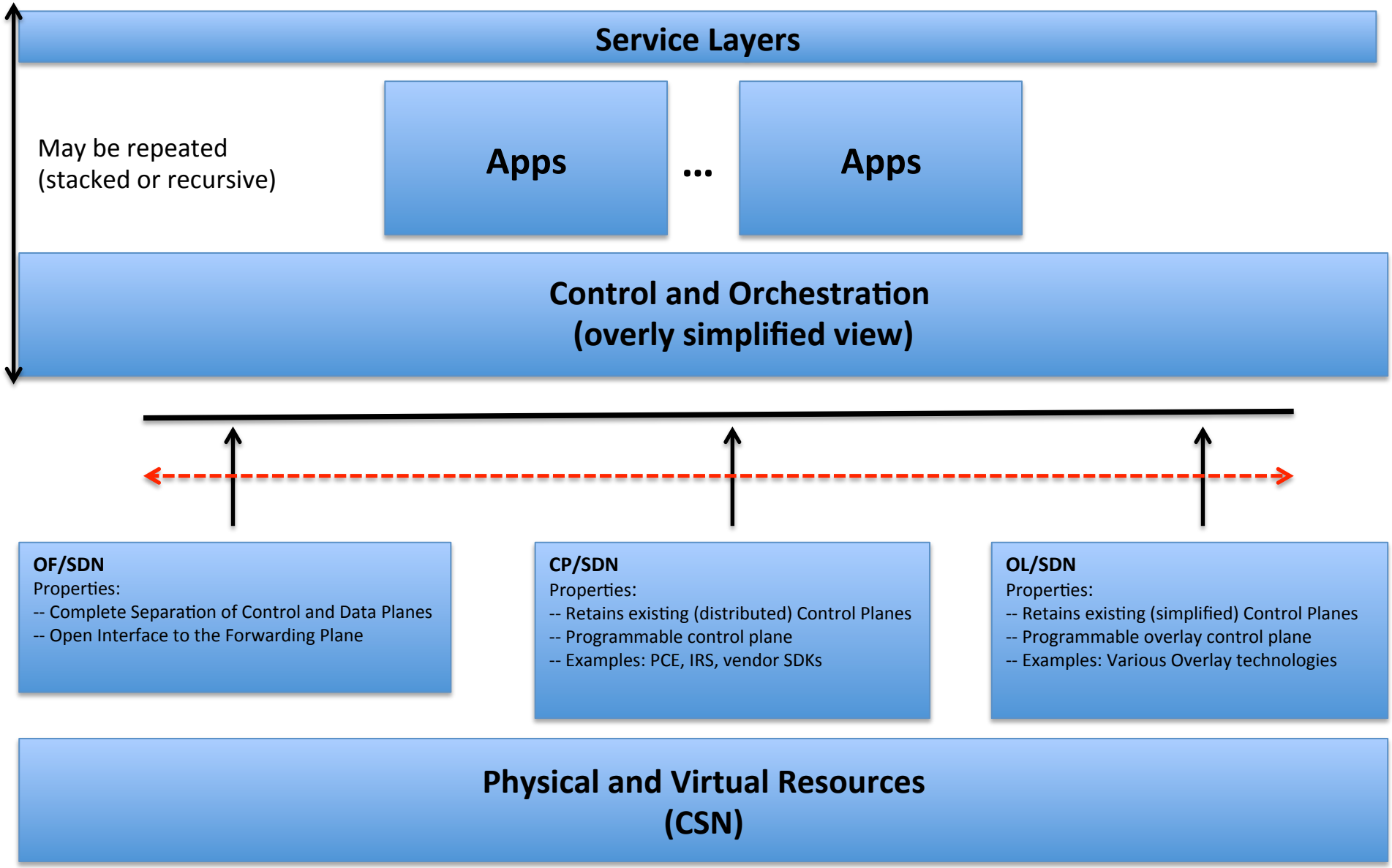
- Why this design? Combinatorics…
- But see also: IETF, ATIS, ETSI, ITU-T, MEF, …
  - I2RS, ALTO, PCE, BGP-LS, ..
  - Different architectural model(s)
- Consider complexity: ~ *O(*n! * l^k) paths
- Emerging: *SDN Continuum*

Too Complex:

- Not implementable on ASIC h/w
- Breaks new reasoning systems
- No fixes for the lossy abstractions
- Architectural questions

Is the flow-based abstraction "right" for general network programmability?

A Simplified View of the *SDN Continuum*

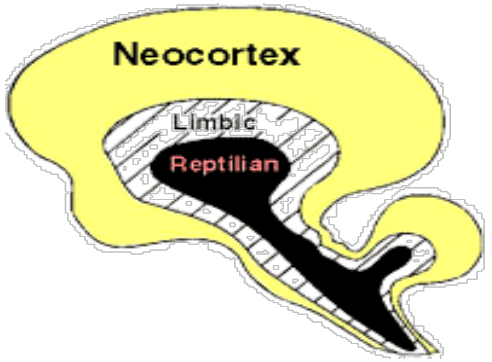


So The Future: Where's it All Going?

But More Seriously….

- High order bit:
  - Cloudy crystal balls, architect for change and rapid evolution
  - "agility"
  - Increasing roles for s/w and programmability

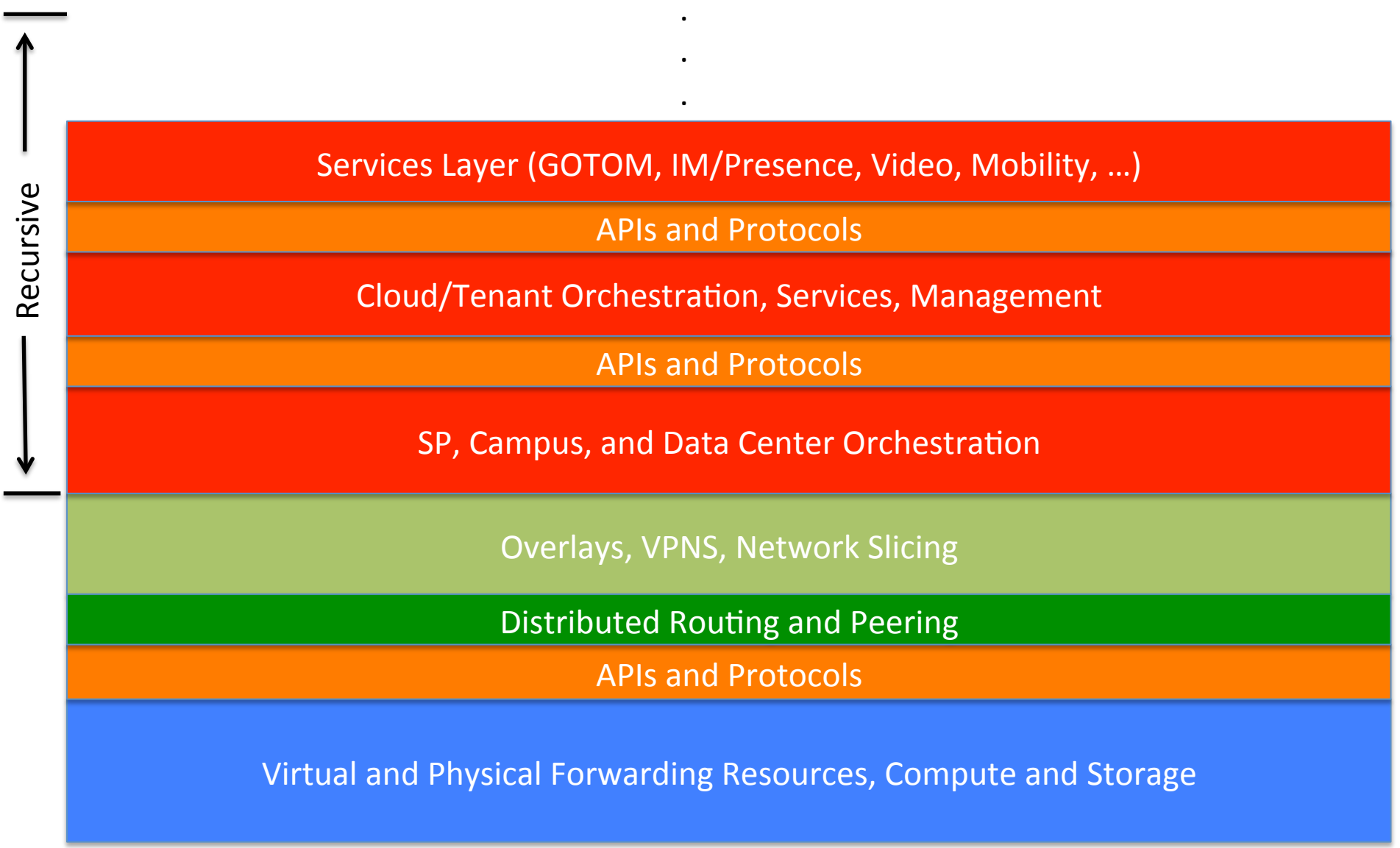
- Conventional Technology Curves – S & F
  - Moore's Law and the reptilian brain
    - Someone eventually has to forward packets on the wire
  - 400G and 1T in the "near" term
  - Silicon optics, denser core count, ….



- Ecosystems
  - Open Interfaces: Protocols, APIs, Code, Tool Chains
  - Open Control Platforms at every level
  - "Best of Breed" markets
  - ***Recursive Programmable Network Stacks***

- BTW, open source/open source consortia dominate
  - And what is the role of standards bodies in age of Open Source?

Programmable Network Stack Cartoon



Finally: A Cautionary Tale

The More Things Change…

(Dave Clark, IETF 24, 1992)

VIEWS OF THE FUTURE

The last force on us – us

The standards elephant of yesterday – OSI.

The standards elephant of today – its right here.

As the Internet and its community grows, how do we manage the process of change and growth?

- Open process – let all voices be heard.
- Closed process – make progress.
- Quick process – keep up with reality.
- Slow process – leave time to think
- Market driven process – the future is commercial.
- Scaling driven process – the future is the Internet.

We reject: kings, presidents and voting.
We believe in: rough consensus and running code.

SLIDE 19

VIEWS OF THE FUTURE

A look at us

What are we good at?

- Responding to short term reality. ← Software
- Building stuff that works. ← Open Source
- Calling bad stuff bad.

What are we bad at?

- Growing our processes to match our size.
- Setting long-term direction.

SLIDE 20

Q&A

Thanks!