6G: The beauty of a simpler network life

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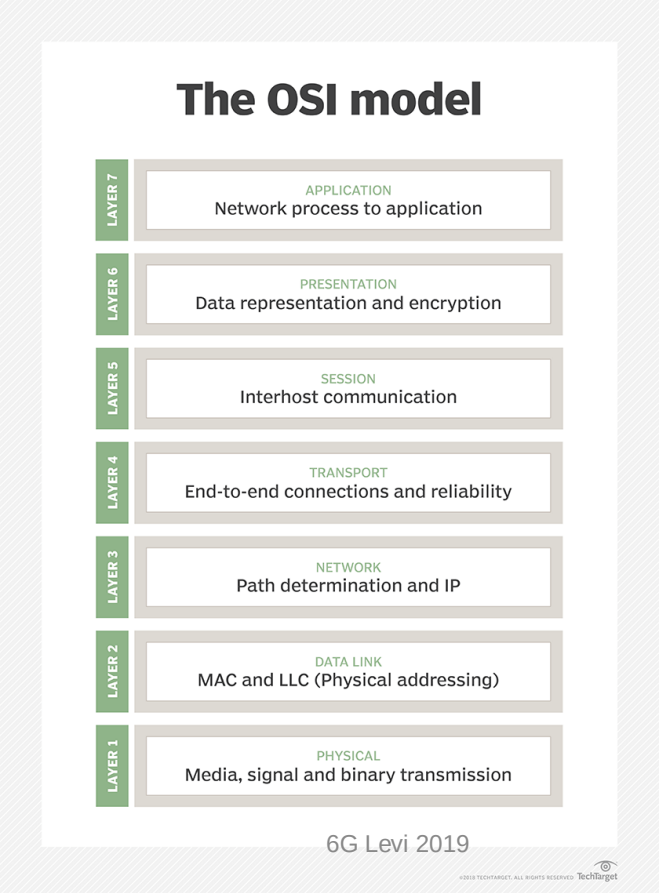
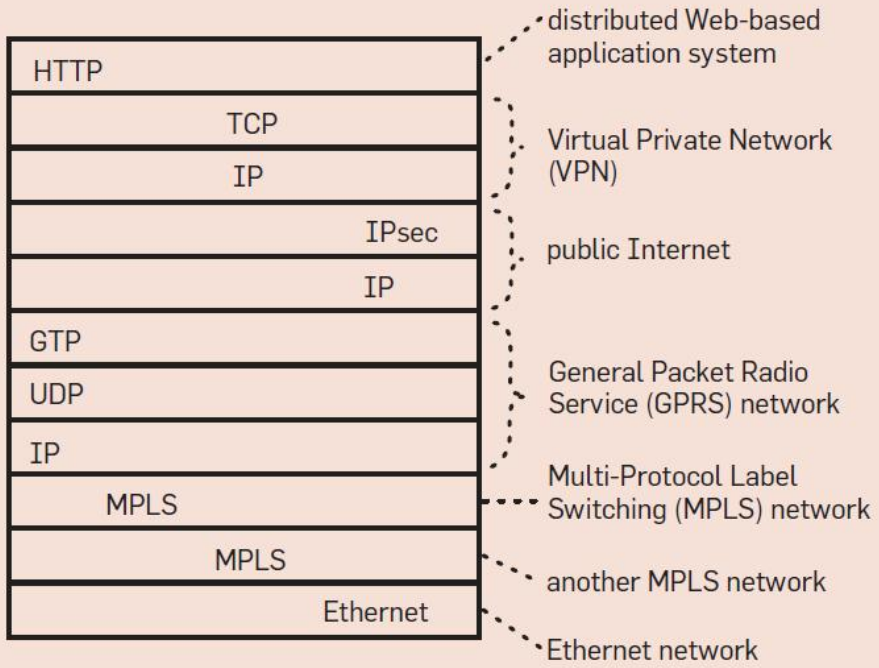
What we learned in networking kindergarten



Mobile reality

Headers lower in the diagram are outermost in the actual packet.



Zave & Rexford, "The Compositional Architecture of the Internet", *CACM 3/2019*

What exactly is a carrier?

AMERICAN TOWER®

40k towers each (US)

CROWN CASTLE

FiberLight

lightower

zayo

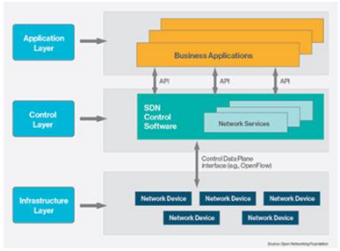
Spectrum DB

Google play

Level3
Cogent

comcast

LTE-U
802.11n
LTE

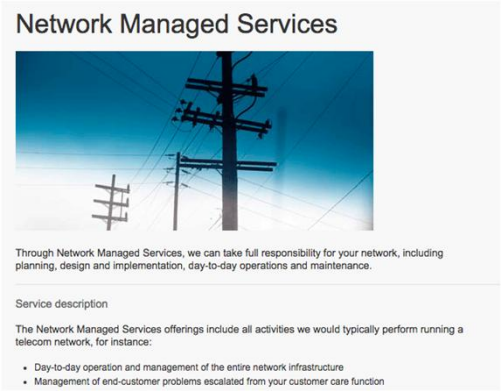


ERICSSON

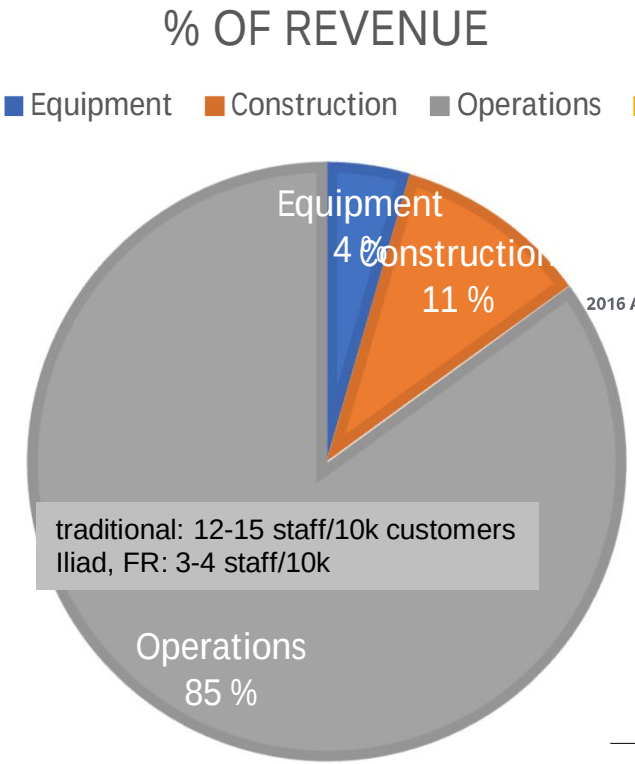
5G: Carriers as consumer brand

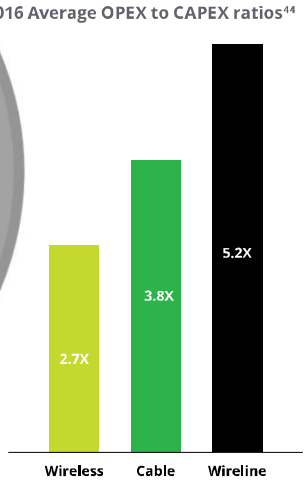
Outside

Inside

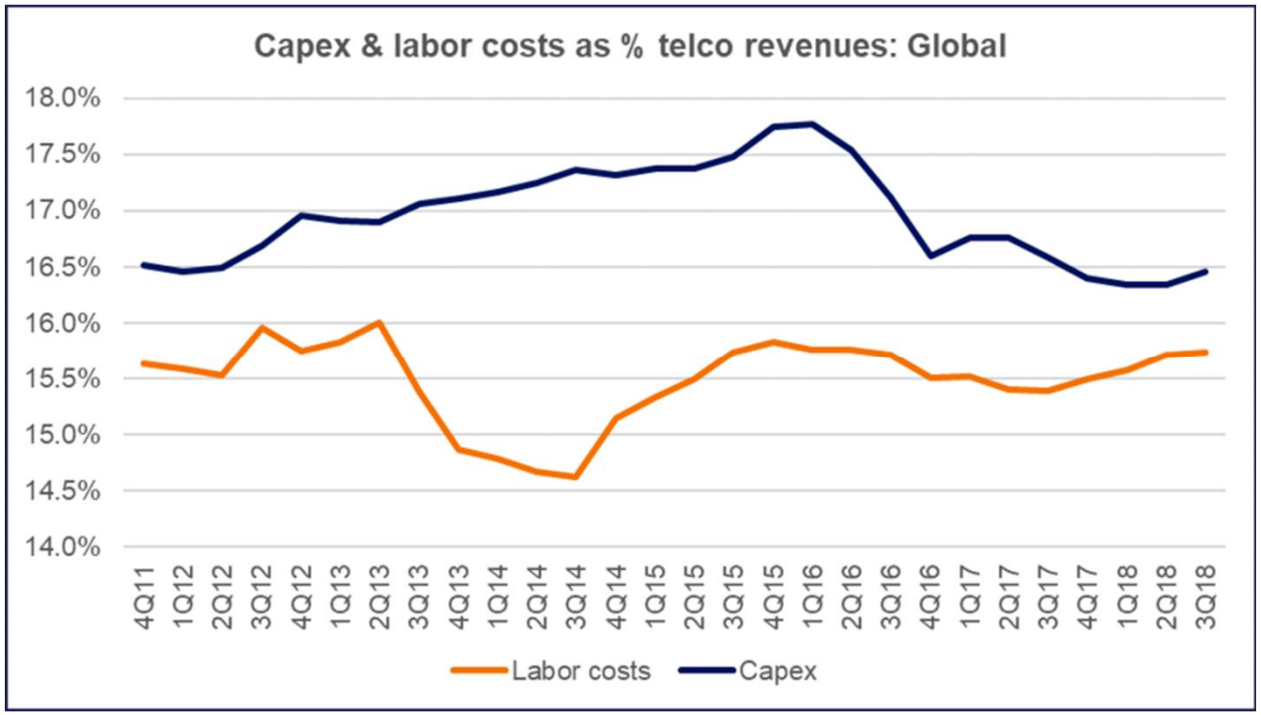


Network economics, (over)simplified

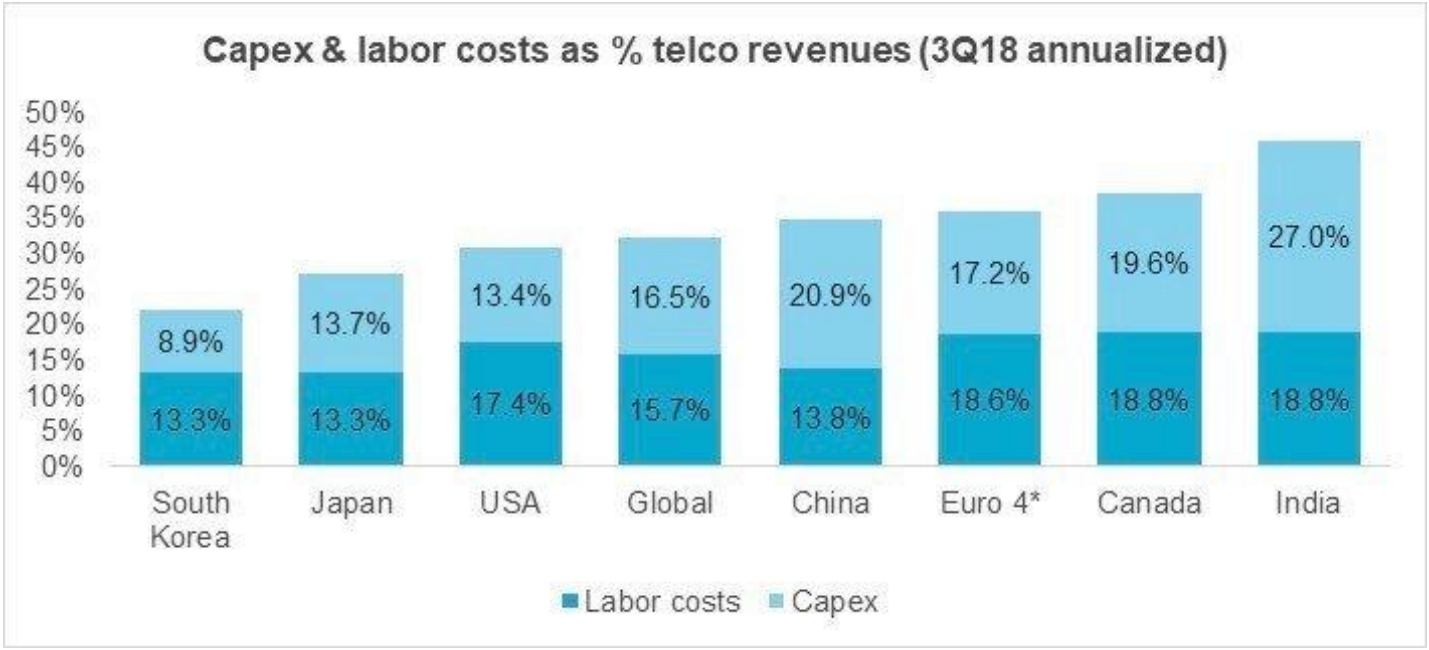




Labor and capital expenditures

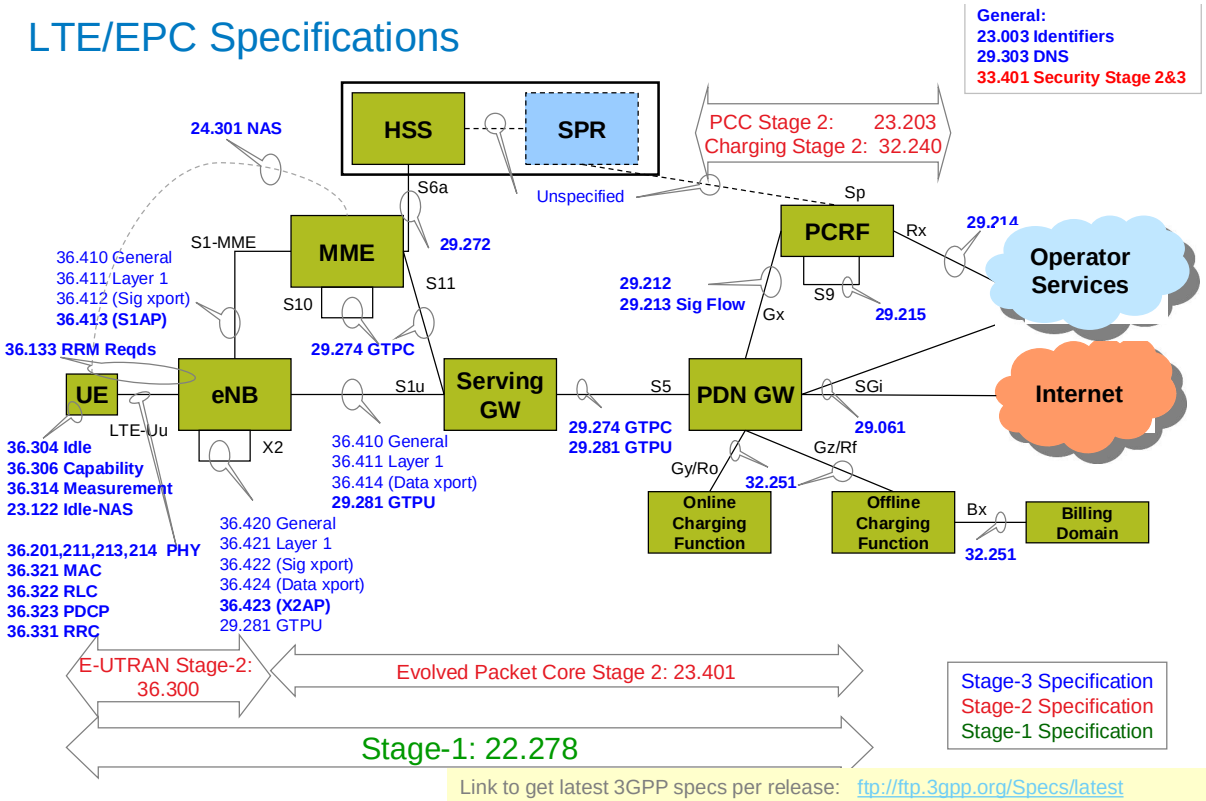


Labor and capital expenditures



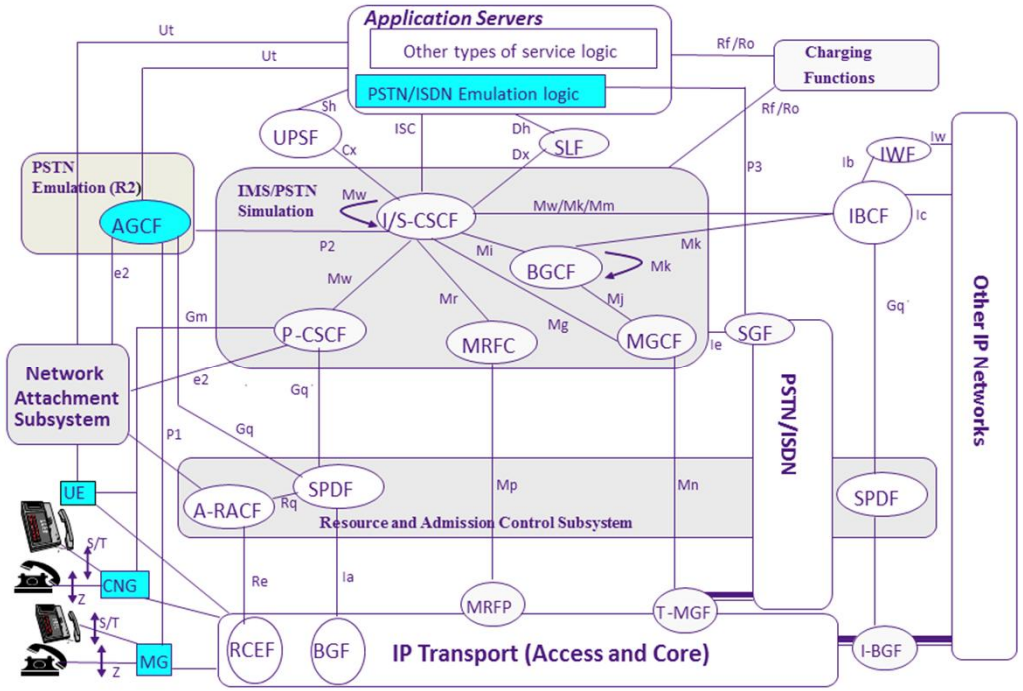
LTE EPC

LTE/EPC Specifications



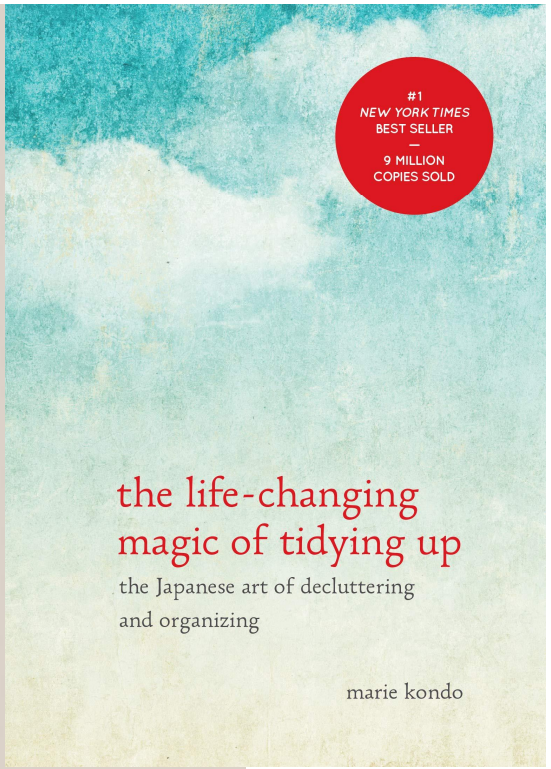
Link to get latest 3GPP specs per release: ftp://ftp.3gpp.org/Specs/latest
Link to find out what a spec covers: http://www.3gpp.org/Specification-Numbering

Complexity kills



IMS


TIDYING UP
WITH MARIE KONDO


#1
NEW YORK TIMES
BEST SELLER
—
9 MILLION
COPIES SOLD
the life-changing
magic of tidying up
the Japanese art of decluttering
and organizing
marie kondo

How does this relate to 6G?

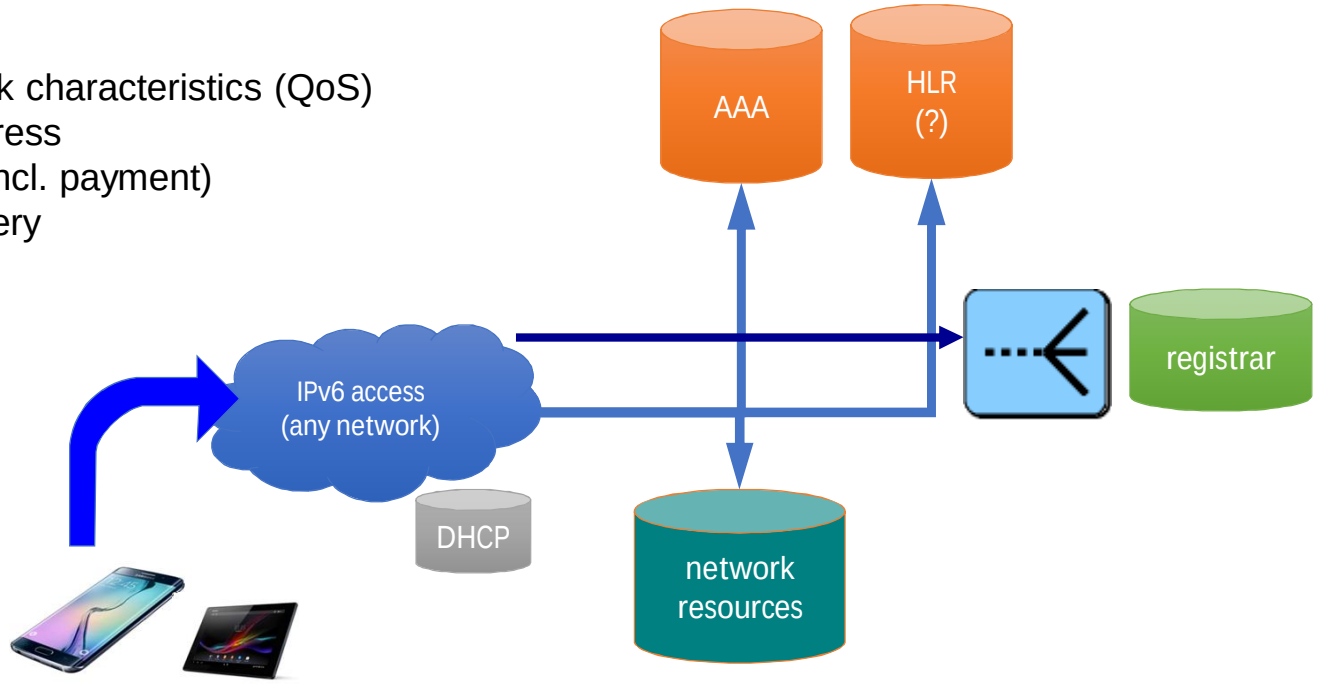
- “Get rid of what doesn’t spark joy”
- Does ASN.1 spark joy?
- Which recent carrier application still sparks joy? JOYn?
  - WAP? IMS? Billing?
- What do students learn (on their own) in CS – AWS (or GC) or ONAP?

Protocols matter, but programmability matters more

- Nobody wants to program raw protocols
- Most significant network application creation advances:
  - 1983: socket API à abstract data stream or datagram
  - 1998: Java network API à mostly names, HTTP, threads
  - 1998: PHP à network input as script variables
  - 2005: Ruby on Rails à simplify common patterns
- Many fine protocols and frameworks failed the programmer hate test
  - e.g., JAIN for VoIP, SOAP for RPC
- Most IoT programmers and factory automation specialists will not be computer scientists (and won't have a telecom background)
- Nobody learns ONAP in their CS BS

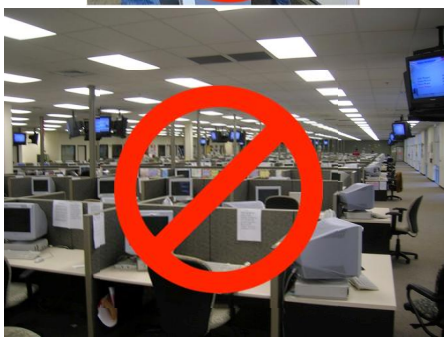
What's the simplest network?

network characteristics (QoS)
IP address
AAA (incl. payment)
discovery



one subscriber, multiple devices, multiple providers

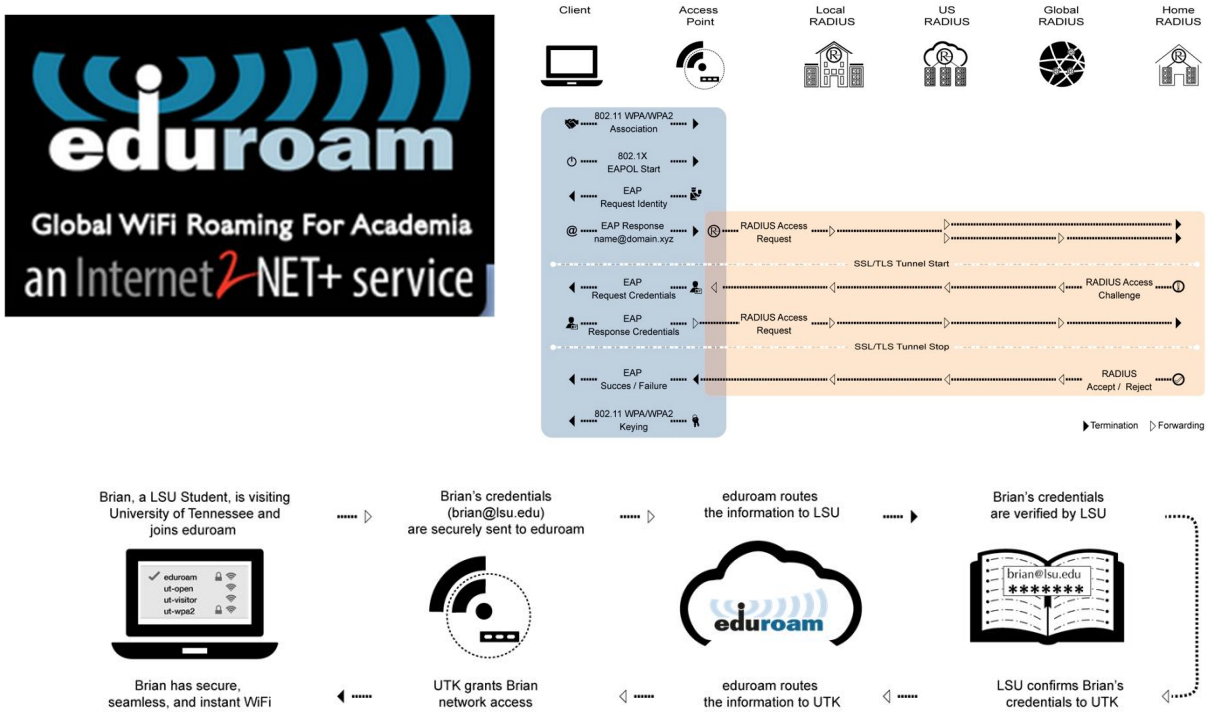
Simplify enrollment and authentication



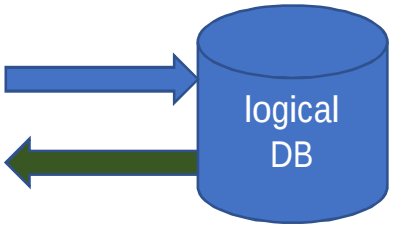
enable access

Public-private key
(like ssh or TLS)

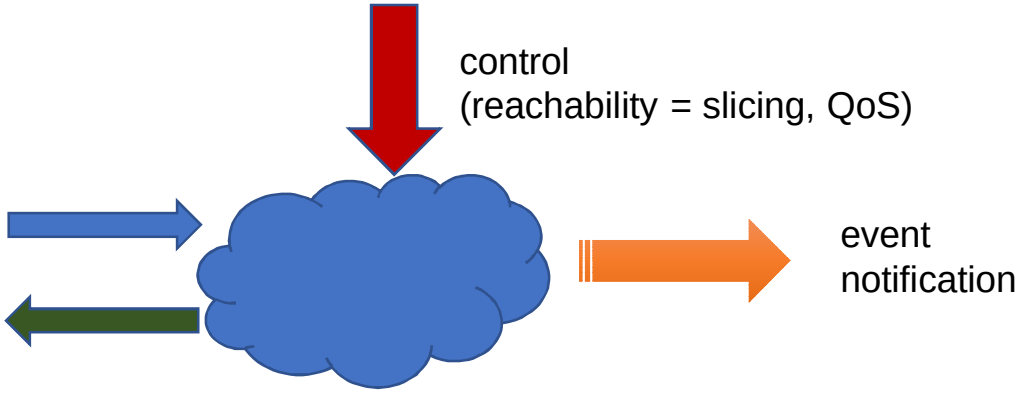
5G prototype: Eduroam



What else is needed for a simple network?



NoSQL-like
(see also DOH)
unify DNS, DHCP, HLR, …



network properties
(reachability packet loss, …)

per-user, not just SNMP or NETCONF

Requirements for simple networks

- Separate link layer from network architecture
  - Why can't 5G (or 6G) NR operate on a home router, without a carrier?
  - Assume flexible spectrum access (geo database)
- Every interface must be testable and self-testing
- *Interface neutrality* = every control needs to be accessible to network consumer, not just operator (bounded by slice or authorization)
- Clean interfaces particularly at layer 2 and 3
- No configuration files, ever
- No hard-coded addresses (e.g., gateways), ever

Scalable networks

no PhD (or carrier training) needed!

firewall
DNS
edge computing

mesh backhaul

large enterprise
management

identity management and trust still deficient

Making networks joyful again

- Simple networks à reliable & cheap networks
  - lower required expertise
  - most network failures are not radio failures: DIAMETER, security misconfiguration, routing loops, …
- Have continued to accumulate protocols
  - replicate security (badly) for DNS, SNMP, DHCP, mobility protocols à unified model
  - still using ASN.1
  - assume separation of management and data responsibility
  - à applications cannot reliably discover network capabilities & diagnose failures
- The even generations are the revolutionary ones è opportunity to move beyond TDM and 1980's Internet legacy