SUCCESSES AND CHALLENGES IN THE IN THE INTERNET ARCHITECTURE

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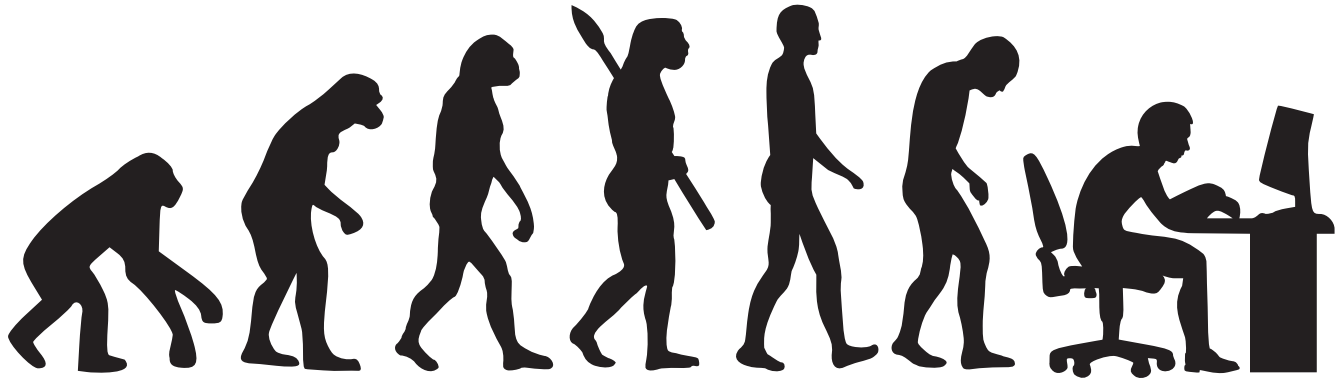


*) A lot of credit for the work going to my colleagues at IAB and Ericsson (Kühlewind, Huitema, Camarillo, Mansfield, Sarker, etc.) but opinions expressed here should be interpreted as mine only

Agenda

What is happening with the Internet?

- Covid-19 impact
- Case encryption
- Case QUIC

Key ingredients of Internet's success

- General or optimized?
- Approach to modularization
- Developing successful technology

Key issues and ingredients for future

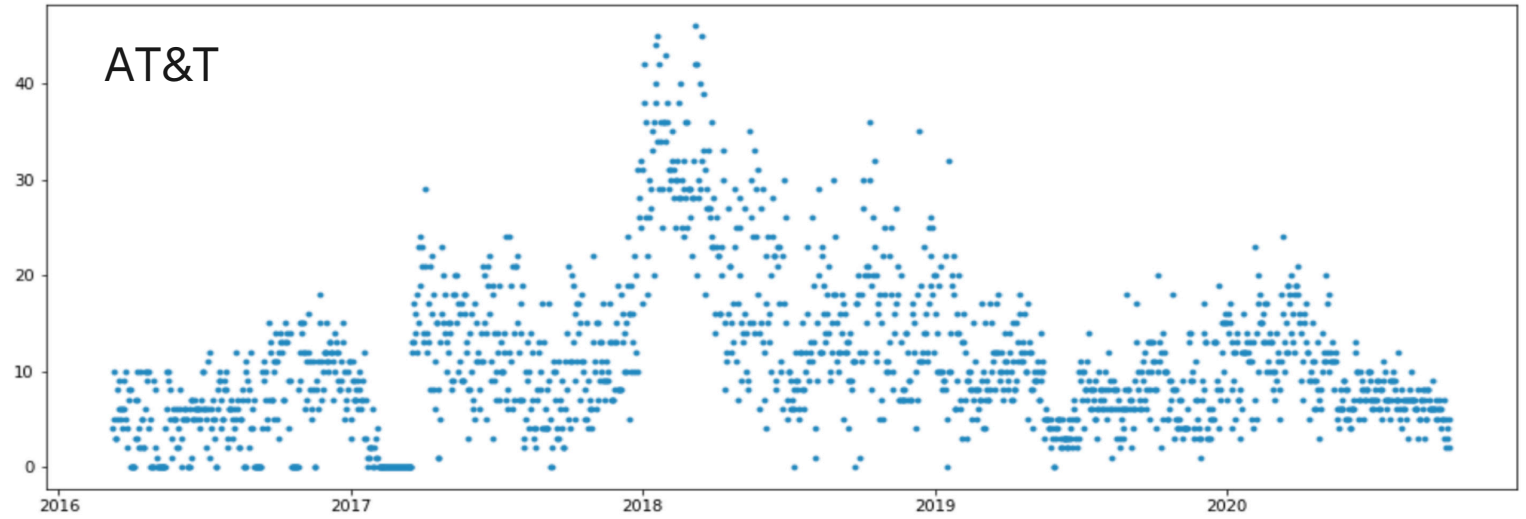
- Trends
- Different perspectives and challenges
  - Focus only on communications security
  - Losing collaboration
  - Centralization
- Vision for a better Internet

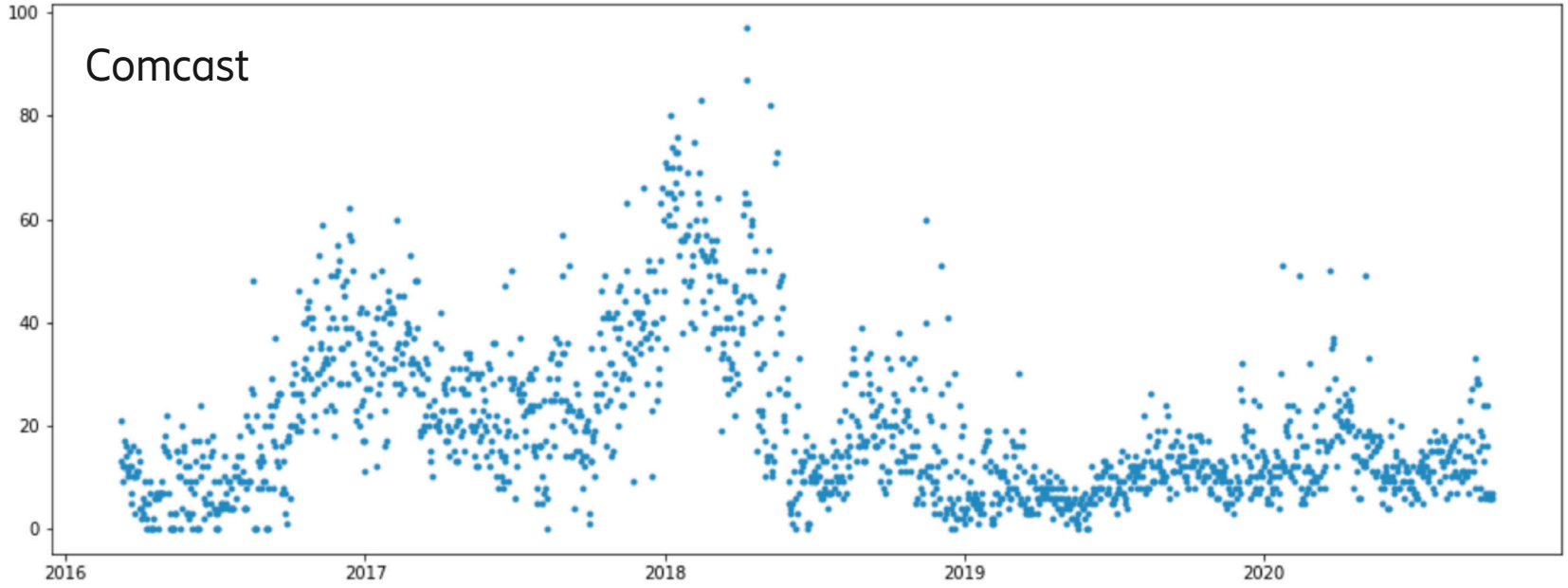
Internet Is 50 Years Old, But Is It Agile?

Source: D. Clark, IAB workshop on Covid-19

COVID-19 impact on networking

- Large traffic scale changes
  - Time
  - Location
  - Applications
- Networking impact on humans
  - Hours
  - Types of use
  - New groups of users
- Perceptions

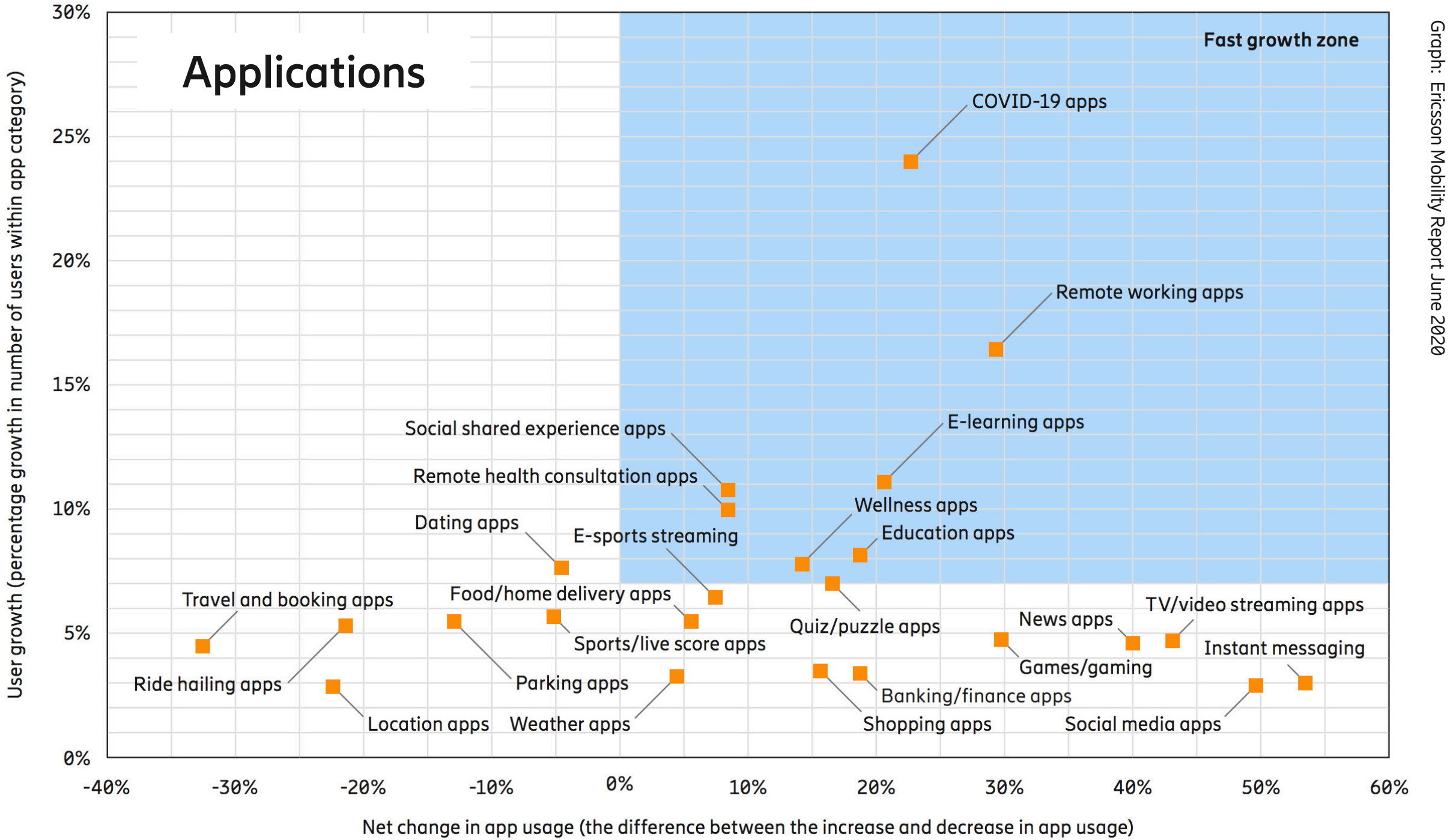




83%

Of the survey respondents, 83 percent claim that ICT helped them a lot, in one way or another, to cope with the lockdown.

Source: Ericsson Mobility Report June 2020



Graph: Ericsson Mobility Report June 2020

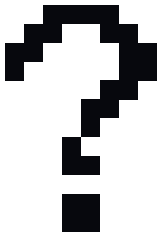
Internet Is 50 Years Old, But Is It Agile?

What happened during the pandemic?

- Capacity was expanded, upgrades moved forward, etc.
- Lots of people/orgs were highly motivated to ensure good experience
- Cloud and CDN deployment models helped re-shape traffic to entirely different applications

How did the Internet do?

- There are some results from a recent IAB workshop
  - "Internet did well" -- reasonably good situation, even during the pandemic
  - See https://www.iab.org/activities/workshops/covid-19-network-impacts-workshop-2020/
- The Internet is well suited for adapting to new situations, but there are also issues:
  - Limited visibility, control, and collaboration
  - Digital divide amplification
  - All the other improvements we need anyway



Case Encryption

Turning security on for almost all connections

- From 20% to 80% in five years
- Incentives, world events, and technology came together
- Role of web protocol evolution (e.g., HTTP/2)
- Role of Letsencrypt
- Role of business incentives

Work continues

- Transport protocol headers
- Control protocols (DNS, TLS setup phase)

Case QUIC

New transport protocol ("Quick UDP Internet Connections")

- Standard developed by the IETF Nov 16 – May 21 (RFC 9000)
- Widely deployed in the Internet, 20+ implementations
- Optimized for HTTP and latency, multiplexing, address migration
- Designed to avoid ossification and enable future evolution
- But also impacts manageability and debugging

Side-effect: from now on, evolution will be faster

- Implementations are in user space, part of applications
- Middlebox interpretation of protocols no longer slows deployment

Key Ingredients of Internet's Success

General or optimized?

- Not particularly optimized for any application or technology generation
- Doesn't have all features

- But is available and (relatively) simple
- Can be used for new applications with asking for permission from anyone "Permissionless innovation"

- Has managed to scale from 1.2 kbit to 1 gbit/s and to 4.7B users

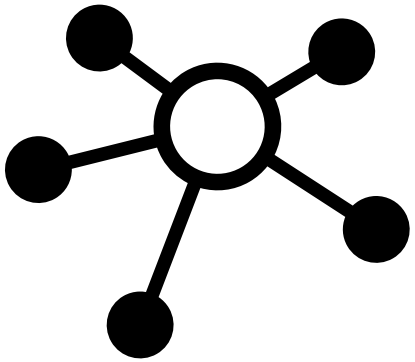
"Internet doesn't support audio/video/VR/hologram/…"

- There is always a future application that cannot be used today
- Tradeoff: optimizing network or app, or waiting speeds to go up

Key Ingredients of Internet's Success

Approach to modularization

- Independent evolution for different parts
  - Endpoint software can evolve without network impacts
  - Counterexample: transport protocols
- Deployment model can evolve without impacting protocols
- Protocols and components reuse
- Use it or lose it



Key Ingredients of Internet's Success (RFC 5218)

Important initially
- Very positive net value
- Incremental deployability
- Availability of code, specs

Less important initially
- Technical design
- Maintenance

Important for wild success
- Extensibility
- No hard scalability limits
- Good enough security

Warning signs
- No involvement from those who have to change
- No benefits for early-adopters
- Misunderstanding or ignoring business aspects

Trends

Technology and Protocols	Applications and Users	Infrastructure
Increased encryption	Application and device diversification	Growing clouds and CDNs
Transport/web evolution	Independent applications	Worldwide distribution
Increased speed of evolution	Greater use of user's data	**Consolidation and Centralization**
	More powerful end-to-end applications and content providers	

Different Perspectives in the Ecosystem

Who shapes the future? And to which direction?

- Tech companies, businesses, and governments
- Different levels of understanding today's networking
- Different interests, market positions, perceptions of needs or what solutions are acceptable
- Different opinions about how to develop things

"Application is king"
... and the next application changes everything

"Lock down" vs. "user control"
Regulation, national control

"We take your data to protect you"
Commercial surveillance

"Telecom dream"
resource reservations, central role of network

"We need to start over"
Clean slate vs. evolution, top-down

"Everything in the cloud"
Centralization, Competition, geopolitics

Challenges 1

Security, security, and security!

- Tremendous success in communications security
  …. but that is only a part of the solution

- What about susceptibility to DDoS attacks? (Dyn 2016)
- Resilience against failures? (Fastly 2021)
- Commercial and other surveillance? (Too many cases to include)

- We need to go beyond communications security
- Example: good that DNS queries are becoming encrypted, but not good that they are increasingly answered by the same few services

Challenges 2

Losing collaboration

- Applications are becoming largely independent and proprietary systems – not interoperable global, multi-party systems
- Even existing applications such as email are degrading towards fewer number of entities that can successfully run them
- Application - network collaboration is becoming extinct due to encryption
  - Clearly, we needed encryption
  - But can we accommodate useful functions (optimizations, debugging, giving guidance to the network)?

Challenges 3

Centralization and Consolidation

- Many applications have a centralized deployment model
- Many Internet services are becoming “winner takes it all” model
- Risks for resilience
- Users may not have a real choice or say in conditions of the service offers

Vision for a Better Internet

Challenges

- Security
- Collaboration
- Centralization

Possible directions

Broad approach to security

- Protecting data at rest and in use as well as in transit
- Work on resilience, reliability, fault tolerance, and DoS defences
- Security assurance practices

Collaborative Internet

- App and network awareness of each others' needs and current situation
- Explicit, engineered collaboration
- Globally interoperable applications

Distributed services for infrastructure functions

- Awareness, measurements
- Important to ensure federation, discovery, etc. are options in standards

Conclusion

- The Internet is alive and kicking!
- Speed of changes is increasing
- Changes that have clear demand can happen rapidly
- Looking forward to the next episodes in the evolution saga
- Don’t always believe what it is said on the Internet, even about the Internet