Sixth ITU Workshop on Network 2030

Lisbon, Portugal, 13-14 January 2020

Session 1: Visions and Challenges

Takeaways and Conclusions

1. **The network of control**

   Key points: 1) 5G will be very popular and widely deployed 2) Data Plane will be handled in next years 3) Until 2030, the Control Plane will have big changes

   Conclusion: The Network of Control is a challenge and must be addressed in next years

2. **Beyond 5G, European Perspective**

   Political Agenda: 1)European Green Deal 2) An Economy that works for people 3) A Europe that fits for Digital Age 4) Promoting European way of life 5) A Stronger Europe in the World 6) A new push for European Democracy

   Proposals: 1) Partnership for Smart Network and Devices Under “Horizon Europe 2021 to 2027” 2) Takes the Value Chain Approach

Suggestions to FG NET2030

- ❑ **More study for Control Plane**
  - New requirements for control plane and management plane
  - New control plane/management components and functions
  - New interface between control/management plane and data plane
  - New Technologies for new Control/management Plane
- ❑ **More study for European Perspectives for Network beyond 5G**
  - Implications for Future Network by Europe Political Agendas
  - Future Network should be
    - More Energy Efficient
    - Benefit More People and Economy
    - Easier to Access for People and for new Applications
  - More liaison communications and Joint Projects between ITU and EU for Future Network

Session 2: New Technologies I – Yan Shen, *Decentralised network resource management and trust models*

Takeaways and Conclusions

1. Network services rely on trust infrastructures to ensure connectivity, service, availability and credibility. Current network infrastructure lacks these to varying degrees and has many security risks.
2. If the authority node in a centralized trust model is compromised, multiple security issues open up.
3. Distributed/decentralized infrastructures, can protect whole systems from single trust anchor failures, improve privacy and security, and, can work in conjunction with existing trust models.

Suggestions to FG NET2030

- FG NET2030 should consider:
  - A decentralized network infrastructure potentially based on distributed ledger/blockchain technology to create trust;
  - Alternative technologies that may also offer secure decentralized platforms; and,
  - IP address and domain name management, and access control methodologies.

Session 2: New Technologies I – Prof Yongmao Ren, *Challenges for Network 2030 faced by scientific applications*

Takeaways and Conclusions

1. 'Big Science' has 'big' requirements that cannot be met by current networks.
2. These requirements will be particularly demanding and will continue to grow in terms of:
    1. Extra-high network bandwidth (10's of Tb/s)
    2. Ultra-high reliability (99.9% uptime 24/7)
    3. End to end QoS with dynamic resource allocation
    4. Dynamic on-demand provision
    5. Determined delay guarantees for high volume data transfer to enable meaningful analyses

Suggestions to FG NET2030

- The requirements of 'Big science' applications push the boundaries and often lead to the development of new technologies. FG NET2030 should consider the growing and demanding requirements in its architecture discussions, and examine which technologies have been deployed to solve the challenges faced in these large scientific projects. (e.g. for LHC, the White Rabbit timing solution was developed).

Session 2: New Technologies I – Dr Xavier Priem, *Smart Internet Labs vision of Network 2030*

Takeaways and Conclusions

1. The Smart Internet Lab's vision for Network 2030 is based upon 12 pillars which are: pervasiveness; deep disaggregation; deep edge-ification; multi-layered, multi-tenant neutral hosting; advanced very large scale monitoring; automated and autonomous network operation and management; deep programmability; scalability, resilience and security; low delay and high reliability; up to 100 Gbps to end user; geolocation accuracy; and, time synchronisation.
2. The first pillar, pervasiveness, is essential to support verticals and true digital transformation across society.
3. The cost of ubiquitous connectivity could be balanced by new business models enabled by multi-layered multitenancy and shareability capabilities
4. Deep disaggregation, programmability and "edge-ification" are enablers for pervasiveness.
5. Dynamic scalability, resilience and security will support predictable, trustable and thus guaranteed SLAs for verticals
6. Future networks should be considered as the 4th utility.

Suggestions to FG NET2030

- Consider Network 2030 and future connectivity as a critical utility when making recommendations;
- Consider the 6 dimensions of 'sliceable space' to ensure Network 2030 can support pervasiveness and dynamic resource allocation; and,
- Consider the technologies that enable us to leverage deep disaggregation, programmability and "edge-ification".

Takeaways and Conclusions

1. The rise of services and applications such as mobile 3D internet, real-time ad hoc communities, context aware mobile, interactive context aware gaming and AR/VR will place unprecedented demands (in terms of volumes of data) on networks. The networks need to be ready to carry it all.
2. Sensor networks are emerging as a 'killer' network structure of the future.
3. Hardware in future networks should be easy to deploy and use, as well as meeting performance requirements. Software is a key driver of hardware development.
4. One size (in terms of networks) does not fit all. Parameters such as availability, intelligence and terminal sharing will shape future networks. So, networks need to be flexible and adaptive.

Suggestions to FG NET2030

❑ Ensure that networks are flexible and adaptative, being able to carry enormous amounts of data in an efficient manner;

❑ Consider how networks can take advantage of terminals as sensors to measure and improve network performance, even a vehicle is a terminal;

❑ Network deployment and management strategies should consider human service usage and differentiate between voice and data; and,

❑ Consider the design of future networks from an end goal perspective, which may mean new technologies alongside evolution of existing technologies.

Takeaways and Conclusions

1. The trend in the new telecommunications ecosystems is a reduction in operator footprints and moving towards the interaction and integration with third parties for services, applications and infrastructures.
2. Integration and control of Network 2030 services and infrastructure will require the evolution of network operator assets (New/upgraded hardware) and consolidation of standard abstraction models.
3. Technical advances should come accompanied by new schemas for sustainability.

Suggestions to FG NET2030

❑ Consider:

❑ the implications of new network services (high precision, coordinated services, etc.) on the entire network and how this impacts infrastructure providers;

❑ methods of exchanging information of and between resources, capabilities or services;

❑ how private networks can access additional external services when required;

❑ disaggregation of SW and HW at all levels;

❑ tight coordination between applications and network integration;

❑ new protocols to support advanced functionalities and service segregation;

❑ monitoring and decision making systems; and,

❑ new hardware platforms and new data plane technologies.

Takeaways and Conclusions

1. New applications such as VR and holographic will result in new traffic patterns and network requirements. Scientific research laboratories are already generating vast data sets.
2. High throughput, low latency and fairness are very sensitive to bottleneck buffer size. Buffering stops the network from scaling up for huge bandwidth flows.
3. Current networking methods are not optimum for large scale, high bandwidth application transmission. Huge buffers or fixed pipes are not realistic solutions
4. Decoupling traffic flow from buffer usage can maintain good transmission rates, with high throughput and low latency.
5. Methodologies could be deployed in special managed environments, similar to RDMA and RoCEv2 which have replaced IP in Data Centre environments, to optimise performance and remove communications overhead.

Suggestions to FG NET2030

❑ Consider:

❑ applications and network challenges in transporting data for very large scale high bandwidth applications;

❑ flexible mechanisms and technologies to overcome buffering and cache issues for large data flow applications; and,

❑ new transport models that are application and content aware, and, independent from buffer usage.

Takeaways and Conclusions

1. New IP Technologies (Huawei)

Key technologies: 1)Variable-length address; 2)New Deterministic Packet Scheduling; 3)New User-defined Network Function; 4)Decentralized IP and ID trust model; 5)Multipath and New Network coding for Ultra-high Throughput

2. Internet-Scale Holographical Type Communication (HTC) (Surrey)

Key technologies: 1) Cloud Based Remote Procedure. 2) Intelligent HTC frame buffering and Signaling Mechanism; 3) Content Aware TCP Connection Management

Suggestions to FG NET2030

- **Further Study is needed for ITU**
  - Consolidate the Key Requirements for Future Network
  - Study areas for Net2030
    - Addressing Diversity and its Implication to New IP Header
    - Intrinsic Network Security and Privacy
    - Network Services and Realizations beyond Best Effort
    - Interfaces, Protocols and Signaling for New Network Services
    - Network Operation and Managements beyond Automations

Takeaways and Conclusions

3. Next-Gen Converged Digital Infra.

(EPSRC, UK Research and Innovation)

Objectives: Forge researches for NG-CDI for BT; Creating New technologies for Autonomous operation for future network.

NG-CDI is highly reliable, programmable, virtualized

4. "Computing power network" (China Telecom)

Objectives: Considering the significant trend of network and computing convergence evolution, and the challenges arising by edge computing, computing power network(CPN) provide a computing power scheduling solution based on the deep interworking of cloud, network and edge, which supports high collaboration between computing and network resources, with optimal user experience. Based on the network-centric idea, collecting network resources, computing resources, storage resources and algorithm resources information to network control plane to realize collaborative scheduling.

Suggestions to FG NET2030

- **Further Study is needed for ITU**
  - New Network Architecture may Include following Aspects
    - New Format of IP Header that accommodates diversified scenarios from size to type
    - New Mechanism to Allocate, Assign and Verify IP Address, AS number and Other Network Resources
    - New Trust Model for Better Privacy and Intrinsic Security
    - New Algorithms, Hardware and Chip Designed for Deterministic Packet Delivery
    - New User-Network Interface
    - New Technologies to realize ultra-high bandwidth applications like HTC
    - New Technologies for Autonomous Network Operations

Takeaways and Conclusions

1. UCL EEE research areas focus on service-aware ultra fast future networks, including AI based intelligent solution, service based routing, management plane driven by declarative high-level intents, high-precision new IP, network programmable is key issue for future network evolution.
2. Consider about the network security issues, a trustworthy network architecture based on block chain technology has been proposed. It is already build a testbed based on the CNGI.
3. Network 2030 should consider the regulation by involved in AI and Holographic Intelligence.

Suggestions to FG NET2030

- ❑ FG NET 2030 should consider new technologies, including AI, service based routing, intend based network, high-precision new IP and network programmable.
- ❑ Decentralized technology such as block chain could be considered in the architecture of network 2030.
- ❑ Regulation about network 2030 should be considered especially for AI and Holographic Intelligence.

Takeaways and Conclusions

Service Assurance for High-Precision Network Services

1. Service assurance for high precision services is more important to ensure smooth, continuous service delivery.
2. Different metrics and flow characteristics and methods to capture were covered.
3. However concerns are being raised about the complexity it brings to the implementing systems. The cost of building such systems was questioned, vis-a-vis the benefits of providing service assurances.

2030: From satellite to earth. One world One Network

1. Time and location are native characteristics of Satellite communication they shall be associated to addressing for
2. Building new protocols for satellite network layer will require Operating system changes.
3. Topic of standardization of network protocols and architecture for integrated terrestrial satellite networks was raised. Also mentioned that satellites can bring topology simplicity.

Suggestions to FG NET2030

- ❑ To further study and highlight economic benefits and energy consumption for high precision services and their assurance models.
- ❑ Study and provide a key complexity attribute matrix that may service as guidance for different solution proposals.
- ❑ Approaches to Network 2030 should be compatible with integrated terrestrial-satellite networks.

Takeaways and Conclusions

1. Open Networking Foundation (ONF) is creating open source solutions for network infrastructures, and Open Mobile Evolved Core (OMEC) becomes available.
2. Because quantum computer can crack widely used cipher algorithms, quantum-safe cryptographies are under development and will be standardized.
3. Packet switched network may not satisfy bandwidth demand for datacenter, and circuit switching could be candidate to solve this problem.

Suggestions to FG NET2030

- ❑ Network infrastructure is moving to VMs/containers base platform, and next generation network should achieve high performance such platform.
- ❑ Future systems including network and services need to be designed securely against quantum computing keeping the performance and usability.
- ❑ According to growth of bandwidth demand, new network architecture including circuit switch should be considered.