Future (Inter)Net(Works): FINe

Master in Innovation and Research in Informatics

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**Question** 1 **(1.5 points)**

1. BGP allows each domain to define its own routing policy, but in practice there are two common policies, namely **Customer-provided peering** and **Shared-cost peering**. Briefly define each of them.

**Customer-provided peering** is when customer **C** buys Internet connectivity from provider **P**. We say that **P** learns **C**’s customer routes and p provides paid transit for **C**.

**Shared-cost peering** is when **AS (Autonomous System)** **X** and **Y** agree to exchange reachability information (customer routes) by using a direct shared link through an inter-connection point.

1. Knowing these routing polices, mention thee of the causes **limiting the inter-domain routing (BGP) scalability**. There are more, but you just have to mention three of them.

* **Many prefixes that are growing too fast**
* **IPv4 address exhaustion**
* **Hard to perform Ingress Traffic Engineering**

1. Cite the **three critical security threats** introduced by BGP, and **explain in on line** of text **when** each of these threats occur.

**Question 2 (1.5 points)**

1. Out of the following four sentences only one corresponds to **the correct description of** **RINA**. Mark it with a cross (**X**).

* **RINA** stands for “Recursive Internet Architecture”, and is **just another patch** to improve the performance of the current TCP/IP network architecture.
* **(X) RINA** stands for “Recursive Internet Architecture”, and is **a clean‐slate network architecture** for the future Internet. Clean‐slate meaning that it is a complete redesign from scratch of the Internet.
* **RINA** stands for “Reinforced Isotropic Network Adhesive”, and **its most important property** is that it gives the same scalability value when measured in different directions.
* **RINA** stands for “Royal Institution of Naval Architects”, and is **a new Internet network architecture** created from scratch by members of that British institution for a better Internet access from the sea.

1. Briefly describe (in only one sentence each) the four limitations of the “conventional” TCP/IP Internet architecture that **RINA** aims to overcome.

* **Incomplete naming or addressing scheme**: Basically it is refer to the problem of not having specific address for different components in the Architecture such as Nodes, Application and Interfaces
* **Global Internet wide scope of IP public addresses:** The routing tables are huge and still growing and in fact with version 6 of IP this problem is even worst
* **Applications do not have a way to define their QoS:** Having granularity at Application level requiring the Quality of Service from the Network is not possible with current TCP/P
* **No built-in Security:** TCP/IP has no built-in security. Mainly security mechanism are protocols over those or patches.

1. Write the fundamental principle in which **RINA** is based, and then, briefly **define** RINA according with this principle. Note that defining is different of describing, which is what we have done above (in section a)).

**The fundamental principle RINA is based on is IPC (Inter Process Communication). According to this RINA generalizes the model of IPC to apply it network worldwide.**

**Question 3 (1.5 points)**

1. It is well known that Human’s activity has severe impact on the environment, in particular **for what concerns to the energy consumption**, the main consequences being two.

* Which are these two consequences? And in what consists of each one? (max. two lines of text per item).
* **Resources exploitation**: Energy production/consumption require the resources exploitation of the earth
* **Climate changes**: GreenHouseGas (GHG) emissions produces climate changes, global warming & dimming, and pollution
* There are three dimensions/parameters to measure the above mentioned impact. Indicate these three dimensions, and the units to express each of them.
* Energy consumption (Wh)
* GHG emissions (kg CO2)
* Energy Cost (€)

1. For what regards to the Energy problem in Information and Communications Technologies (ICT), occurs a particular phenomenon, known as “**vicious cycle**”.

* Briefly explain in what consist of this phenomenon.

**Basically this vicious cycle means that the more watts we require for consumption due to increasing the level of computational power required, the more cooling down the equipment is required because of the heating of the computation as well. Therefore this cooling also brings more power consumption that is required to the process.**

* Which parameter is used for quantifying this phenomenon? Express its formula.
* Powering Devices
* Cooling
* UPS
* **PUE = Total Facility Energy / IT Equipment Energy**

1. The Energy-oriented Internet paradigm is based on the combination of two concepts, namely Energy-Efficiency and Energy-Awareness. Briefly define them.

* **Energy-Efficiency:** Refers to **technological advances** to reduce the energy consumption without affecting the performance. The **do more for less paradigm**
* **Energy-Awareness:** Refers to **intelligent technologies** able to adapt its behavior or performance to the **current working load**,and to the **quantity**and **quality of energy** that the equipment is expending

**Question 4 (1.5 points)**

1. There are two basic recovery methods usually applied to counteract network failures:

* Cite and briefly define each of them.
* **Protection: Switching to a pre-established recovery path or path segment after the occurrence of a fault.**
* **Restoration: Establishing new paths or path segments on demand for restoring traffic after the occurrence of a fault**

* Which of them performs better in each of these two cases?
* From the **cost** point of view: **Restoration**
* From the **recovery time** point of view: **Protection**

1. When applying a simple escalation strategy, such as for example a **Single-Layer Recovery** mechanism, in each of the layers of an IP over OTN network:

* What problem may arise when using this mechanism without coordinating the actions among the two layers? Be brief and clear.

If we do only at the bottom layer:

* **Inability to recover failures in the layers above**
* **Inability to restore transit traffic in isolated client node**

If we do only at the top layer:

* Lots of recovery actions due to finer granularity of flows
* Complexity of recovery related to multiple secondary failures
* Briefly explain one method to coordinate the actions among the two layer, and avoid this problem.

**Bottom up escalation: After detecting a failure, a protocol layer waits for a hold-off time before initiating its own protection/restoration process. The target restoration time at a protocol layer decides to hold-off time for the layer above. Hold off-time increases as one move higher layers. In the bottom-up the above layer has a Cancel-timer in the Upper layer control plane for detecting link failures from layer bellow. If time expires, start recovery and make a new flow.**

1. The above mentioned escalation strategy among layers is a possible way to recover from failures in a multilayer network, but the **Dynamic Multilayer Recovery** strategy, besides that there is more complex to implement, is much more efficient.

* Briefly explain in what consist the **Dynamic Multilayer Recovery** strategy.

**Requires the possibility to modify a connection in lower layers in real time. It is based on upper layer topology modification for recovery process**

* Cite some possible technologies to implement the **Dynamic Multilayer Recovery** strategy.
* **ASON**
* **SDN**
* **KDN: Knowledge-Defined Networking**

**Question 5 (1.5 points)**

The following figure corresponds to the Knowledge-Defined Networking parading, which can be used either **off line (or open loop)** and **inline (or close loop).**



1. Which of the KDN working modes is the one allowing for taking **automatic decisions**? Mark the correct answer with a cross **X**.

* The off line (or open loop) mode
* **(X)** The inline (or close loop) mode

1. Which is the method used in KDN for modeling the network? Mark the correct answer with a cross **X**.

* **(X)** To create a **Digital Twin** of the network
* The **Analytical** method
* The **Simulation** method

1. Which is the method used in KDN for optimizing the network, that is, for finding the optimal configuration to achieve the targeted performance? Mark the correct answer with a cross **X**.

* Traditional optimization techniques, **such as Heuristics**
* Routing algorithms, **such as Shortest path**
* **(X)** DRL: **Deep Learning** (based on Neural Networks), plus **Reinforcement Learning** (the optimization algorithm)
* Mathematical optimization technics, **such as hill climbing**

**Question 6 (1.5 points)**

As Dr. Sergi Abadal mentioned in his lecture, besides of multiple other usages, **graphene** is key material for the miniaturization of wireless RF communications.

1. **For what can be useful** the miniaturization of wireless RF communications? Be brief and clear.

* **Allowing nanodevices to cooperate among them to perform complex tasks**
* **Place antennas in complex systems, but in a constrain area for example Microchips**

1. **From the point of view of the antennas**, why graphene, conversely to metals, allows for the antennas miniaturization? **Be brief and clear**.

**Graphennas are plasmonic which means that its resonance frequency is much lower than metal**

1. **In the particular case of designing chips multicore**, for addressing/solving which problem it is appropriate to use miniaturized wireless RF communications? Just enunciate the problem.

**Basically for addressing the problem of network communication between the components of the chip**

**Question 7 (1 point)**

Prof. Jens Myrup in his lab session (lecture of November 25th) made you to practice with two tools, namely **Wireshark** and **nmap.**

1. What **Wireshark** is useful for? What kind of exercises did you do with this tool? Briefly, but clearly answer these questions.

**It is useful to do traffic monitoring. Basically we have monitored a particular set of packets in the network to discover and user and password that were transmitted in that packets.**

1. What **nmap** is useful for? What kind of exercises did you do with this tool? Briefly, but clearly answer these questions.

**It is useful for do port scanning in a network. In the exercise we have used it to scan what was the IP that had an HTTP Server open and listening in the Port 80**

**Question 8 -Bonus question- (1 point)**

Elaborate a question dealing with the topic of the **Technical Report** that you and your groups mates have worked on. Take care to not propose an extremely easy or a too difficult question, it has to fit with the technical level given in your presentation.

1. **Propose the question:**

**What are the Industry proposed solutions to improve IoT Security in 5G Networks?**

1. **Answer the question:**

* **User privacy protection: the machine to machine user equipment could be detached from the network when no data is exchanged. It would enable to avoid superfluous tracking of information and therefore protect the privacy of the user better.**
* **Small data protection: Control plane based solution: partially cipher the small data that is transferred**
* **Security for URLCC. URLLC is a set of features providing low latency and ultra-high reliability for mission critical applications (industrial internet, smart grids, remote surgery and intelligent transportation systems).**
* **Differentiated security by network slicing: It is a concept of virtual cutting of the network into several slices. Each slice is associated with different performances. Each network slice corresponds to a use without interfering with the others. So each of the slice can have its own protocols and security functions which is a big advantage.**