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3G Networks: Opportunities and Challenges

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Abstract: Several applications of practical interest stem from the capability to monitor and store packet-level traces in a 3G network. Among them, the possibility to infer and locatenetwork problems (e.g. persistent shortage of capacity, or equipment misfunctioning), in the core and radio sections, without direct access to the equipments. This approach yields strong practical benefits, given the costs and complexity of accessing network equipments, especially in the Radio Access Network. At the same time, it exposes practical issues - e.g. the need to dynamically locate the traffic sources (Mobile Stations) - and theoretical problems - e.g. inferring congested cells from Routing-Area level TCP measurements. We report on our work- in-progress aimed at implementing such mechanisms on top of an advanced monitoring system now deployed in an operational network.

1. INTRODUCTION

Public wide-area wireless networks are now migrating towards third-generation systems (3G), designed to support packet-switched data services. Europe has adopted the Univer-sal Mobile T elecommunication System (UMTS), developed by 3GPP as an evolution of GSM. A 3G network includes two main sections: a packet-switched Core Network (CN), which is based on IP, and one or more Radio Access Network (RAN). Along with the UMTS RAN (UTRAN) based on W-CDMA, several operators maintain a parallel GPRS RAN evolved from the legacy GSM radio. This structure is sketched in Figure.1. Several UMTS networks became operational since 2003 while first deployments of GPRS date back to 2000. Since then, the growing popularity of 3G terminals and services has extended the coverage of Internet access to the geographic area, and 3G networks are becoming key components of the global Internet in Europe. However the 3G environment is still under evolution, at least along the following dimensions:

- subscriber population and traffic volumes;
- Terminal capabilities and relative penetration of the vari-ous terminal types (handsets, laptops with 3G card, etc.);
- Service portfolio and tariffs offered by theoperators.

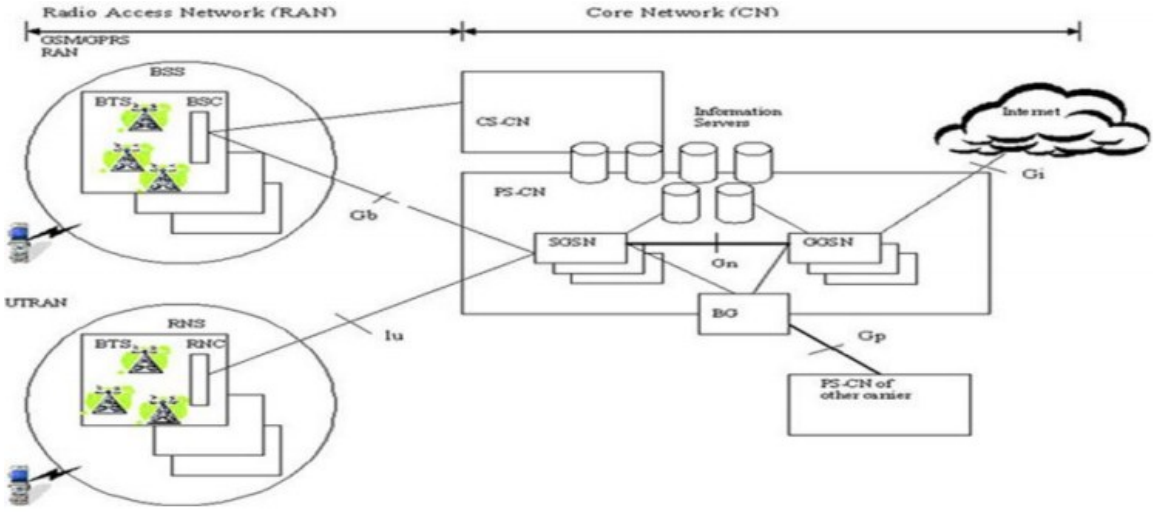

Fig1: Relationship between UTRAN, GPR AN AND CN

Furthermore, technological upgrades are still in the agenda ofmany operators: EDGE in the GPRS RAN, HSPDA in the UMTSRAN, and IMS in the CN [1]. All these aspects collectively build a potential for changes in the global traffic that can occur at the macroscopic scale (network-wide) and in a relatively short time frame. Hence, the ability to accurately and extensively monitor the network state and to early detect drifts in performance and/or local troubles is a fundamental pillar of the network operation and optimization process.
Monitoring a wide-area network is not an easy task. First, the number of elements is large and they are spread geograph-ically . Secondly, for most practical purposes it is necessary to access configuration parameters (e.g. provisioned banwidth), logs and counters from several network elements, with different software and from different vendors, and considerable costs, complexity and complications are found in practice where it comes to extraction, gathering and correlation of such heterogeneous data. In summary, installing and maintaining a monitoring infrastructure with direct access to the network elements of the production network is very expensive. Furthermore, the quality and the granularity of the data available from the equipments (e.g. built-in counters) is often poor and/or inadequate for in-depth analysis of the network state. In our research we are exploring the feasibility of monitor-ing a
production 3G network exclusively by passive sniffing Packets on few key CN links, without direct access to the equipments. This approach yields a number of practical benefits, and opens new further opportunities for improving the engineering and peration of a real network. For example, the combination of location data extracted from the signalling frames with TCP performance indicators (e.g. retransmissions and RTTs) estimated with previously developed methods allows to monitor the actual perfomances of the whole RAN, and to spot the need for local radio re-optimization intervention, without direct access to the RAN equipments. This approach is similar in principle to passive network tomography. Another value point of passive monitoring, when coupled with trace storage, is the possibility to perform post-mortem analysis of network troubles. Applied to 3G, it allows for pioneering research directions unexplored so far, like the assessment of the potential impact of undesired traffic (e.g. worm infections, DoS attacks) onto the functionally-complex 3G infrastructure (an instructive case for the wired network is reported in [4]), or the analysis of signaling traffic to reveal buggy terminals or network misbehaviour on the control-plane. In summary, while such approaches are not novel in the general sense,nonetheless their application to the specific context of 3G networks reveals new unexplored facets. In this contribution we try to enlight the opportunities of fine-grain monitoring a 3G network, with a focus on the problem of large-scale packet-level performance monitoring. We report on the main technical issues and the open points.

2. 3G History and Background

3G has dominated the modern world in just a few years. Although the technology is relatively new, there are already so many devices taking advantage of the functions. You can use it regardless of location, so work and leisure becomes more efficient. You have to know a little about 3 G histories to know how unique it is compared to other updates in the past. Here aresome details and applications of the technology.

2.1 Defining 3G

3G is also called third generation. It is named as such because it is the third generation of the standards of telecommunication hardware. It is also the general technology for mobile networking, passing the recent 2.5G. The technology is founded on the ITU or International Telecommunication Union group of standards which belongs to the IMT-2000.

3G networks allow network operators to provide users a bigger range of the latest services, as it gets bigger network capacity via heightened spectral efficiency. The included services are video calls, wide-area wireless voice telephone and broadband wireless information, all included within the

mobile environment. More features included are HSPA data transmission capacities that can send data rates reaching 14.4 Mbit/s on the downlink and the uplink at 5.8 Mbit/s.

2.2 Networks

Different to the IEEE 802.11 networks, that are usually known as WLAN or Wi-Fi networks, the 3G networks cover a very wide area of cellular telephone networks that turn into incorporate high-speed internet connection and video telephony. IEEE 802.11 networks have a short range, with high-bandwidth networks mainly created and improved for data and information.

2.3 History and Start

The first 3G network offered for commercial use was launched in Japan by NTT DoCoMo. The network had the brand name FOMA and was introduced in May 2001 on a W-CDMA technology pre-release. The initial commercial launch of 3G was also done by NTT DoCoMo in Japan. This happened on October 1, 2001, although the technology was still very limited in terms of scope at the beginning. The broad availability, due toinadequate reliability had to be delayed.

SK Telecom from South Korea was the second network that was released commercially live. This was on the 1xEV-DO technology dated January 2002. In May 2002, the second 3G network from South Korea was on EV-DO by KTF, posingKoreans as the first to view the competition of all 3G operators.

Isle of Man by Manx Telcom was the first pre-commercial network released from Europe. At that time, the operator went by the name British Telecom. Telenor opened the first commercial network in Europe for business in December 2001. There were no commercial handsets, however, so there was also zero clients. These were on the W-CDMA technology.

3. Advantages of 3G

3G has provided a new way of life among mobile phone and handset users. Consumers are quickly getting on the bandwagon and investing in 3G-powered devices and tools. 3G can change the way you look at network, with the various features and effects. You can get ahead and take advantage of the highest details and gadgets by understanding the functions and uses of the system, as well as the available networks. Here are more details.

3.1 The Functions

People can perform a lot of functions such as sending information and data and acquiring these via wireless access. You get to have data regardless of the time and location. 3G is the latest mobile technology and is now the fastest growing host among mobile units and handsets. 3G provides you with the highest speed possible, compared to other technologies before it.

You get to have faster connectivity, music entertainment with better quality and faster access to the internet. The advantages are very side. You can also avail of the benefits of video calling because of the faster speed. You get to enjoy calls to family and friends all over the world with video call facility. The quality and clarity are enhanced, with the facility enjoyable as long as the two parties are using the 3G technology.

3.2 Using the Technology

People can use their handsets and let it function as a modem for their computer to mail and send necessary documents.

Downloading songs and games will be much faster compared to older technologies. People can also enjoy and download their favorite games via their mobile units and play simultaneously. The latest music videos and songs can be acquired very easily. The technology also allows very quick downloads, so you need only a few minutes to download albums and movie clips.

3.3 Getting Information

Getting information is one of the best features of 3G technology. You can also watch the latest news and headlines, getting data like the weather, sports and economic details. You get to acquire the latest scores in an ongoing baseball match and other favorite sports. The 3G cellular phones with the very advanced feature can feature highlights of popular sports and shows. The improved quality of services and speed of 3G phones can allow you to watch music videos and movie clips with crisp and clear photos, compared to 2.5G technology phones.

3.4 Higher Speed

With 3G technology, you get to enjoy data transmission speed leading up to 2Mbps, considering that you have a phone in stationary mode. It also gives you high degree of connectivity and higher networking, plus resistance to noise.The technology has enhanced the bit rate, allowing service providers to give high speed internet facilities, higher call volumes and host of the multimedia applications that can be given to the customers. All the services can be given to the customers based on the data quantity transmitted and not on the time used for the service. The services rendered to clients are cheaper overall.

3.5 On Price

Despite the new speeds and features of 3G technology, the prices of handsets and mobile units are relatively the same. The most recent models, however, may be priced higher compared to those featuring 2.5G. You can avail of discounts and other promos by visiting web sites and other private sellers on themarket.

4. OPPERTUNITIES

4.1 Data rates.

ITU has not provided a clear definition of the data rate users can expect from 3G equipment or providers. Thus users sold 3G service may not be able to point to a standard and say that the rates it specifies are not being met. While stating in commentary that "it is expected that IMT-2000 will provide higher transmission rates: a minimum data rate of 2 Mbit/s for stationary or walking users, and 384 kbit/s in a moving vehicle," the ITU does not actually clearly specify minimum or average rates or what modes of the interfaces qualify as 3G, so various rates are sold as 3G intended to meet customers expectations of broadband data.

4.2 Cost and Affordability:

CDMA 3G technologies offer the greatest data throughput capability and therefore the lowest cost data services. GPRS, a 2.5G, TDMA technology intended to bridge GSM networks to 3G, does not have the throughput and performance capabilities of CDMA. Cascading attacks are a new class of attacks where data corruption of one or two low key data items will result in propagation of corruption to remote service nodes.

• This attack can be specially
Hazardous to the 3G network due to:
– Exchange of signaling messages.
– Dependencies between data items.
– Cached data items.
– Shared databases.

4G Network platform is a positive step towards the creation of a wireless and broadband environment that possesses rapid transmission speeds, cost effective, and better security

4.3 Capabilities and Features:

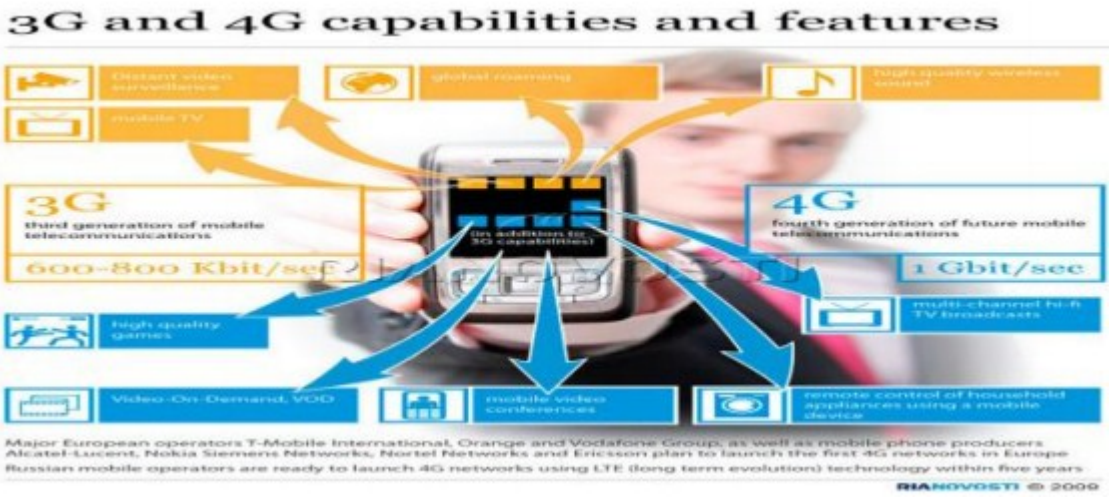

Fig2: Compared Features of 4G and 3G

5. NEW CHALLENGES

5.1 Security and privacy: 3G networks offer greater security than their 2G predecessors. By allowing the UE (User Equipment) to authenticate the network it is attaching to, the user can be sure the network is the intended one and not an impersonator. 3G networks use the KASUMI block cipher instead of the older A5/1 stream cipher. However, a number of serious weaknesses in the KASUMI cipher have been identified.In addition to the 3G network infrastructure security, end-to-end security is offered when application frameworks such as IMS are accessed, although this is not strictly a 3G property.Unlike traditional wired infrastructure, mobile networks has limited radio resources and signaling procedures for complex radio resource management. So these traffic is not a problem in wired networks but mobile networks, it can be a threat.
Recent connection between heterogeneous networks (mobile network and wired network) is sharing mutual security threats.Especially compared to the existing wired network, mobile network security for various abnormal traffic technologies was not ready. Mobile networks as a communications facility is viewed as a national infrastructure, because if it can be backed up with appropriate security technologies by hackers can be a victim of cyber terrorism, economic and social lossfor mobile operators will be greater.

Mobile networks have several features compared to traditional wired environment, it have relatively narrow bandwidth and limited radio resources, and complex signaling protocol for resource management. So these traffic which is not a problem in wired networks but mobile networks, It can be a threat.

COUNTERMEASURES:

Compared with wired networks, wireless networks have a variety of security threats because a special feature of mobile network such as limited radio resource and narrow bandwidth. Although, one could apply of existing security equipment which IP based, but it cannot cover the core network in 3G mobile network. Therefore, we need optimal security system for the 3G mobile network. In Fig. below, the security system can be divided into three parts, the first traffic acquisition system, the second abnormal traffic detection system, and finally control system that can monitoring and control for detected mobile device based on detection information.

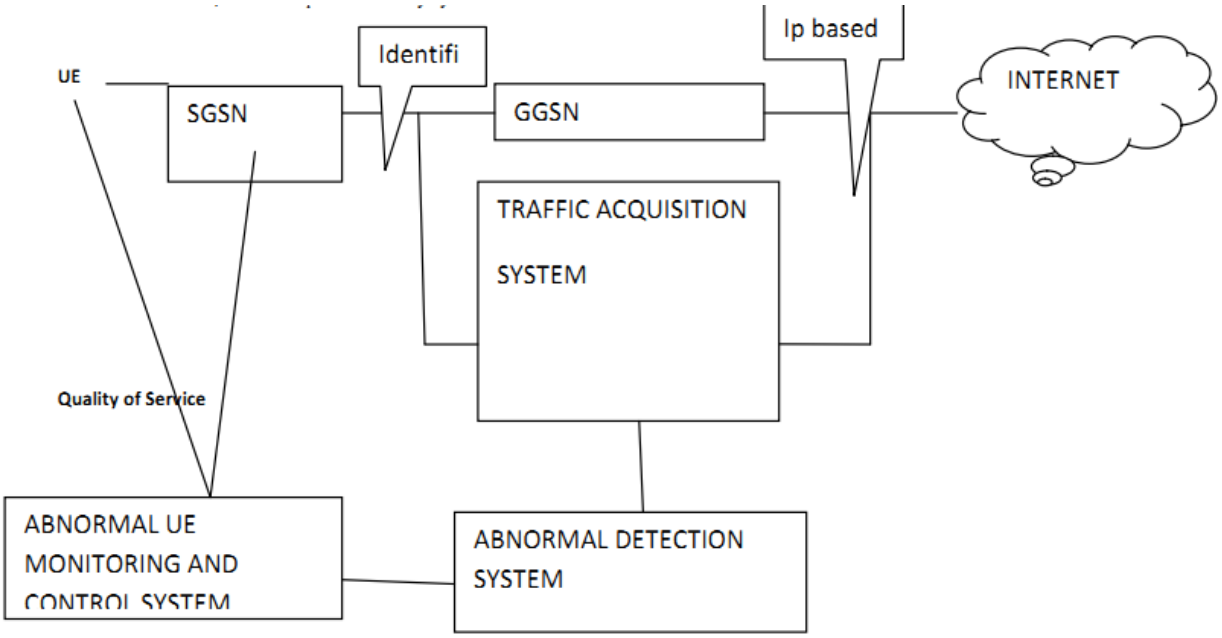

Fig3: ADDING security to mobile, wireless and wired networks

Each scheme has its own algorithm to provide QoS and every scheme has its advantages and disadvantages. QoS schemes which try to incorporate both voice and data have to take into consideration this issue.

5.2 Quality of Service (QoS) in cellular networks is defined as the capability of the cellular service providers to provide a satisfactory service which includes voice quality, signal strength, low call blocking and dropping probability, high data rates for multimedia and data applications etc. For network based services QoS depends on the following factors!

Throughput: The rate at which the packets go through the network. Maximum rate is always preferred.
Delay: This is the time which a packet takes to travel from one end to the other. Minimum delay is always preferred.

Packet Loss Rate: The rate at which a packet is lost. Thisshould also be as minimum as possible.
Packet Error Rate: This is the errors which are present ina packet due to corrupted bits. This should be as minimum as possible

Reliability: The availability of a connection. (Links going up/down).
It is for these reasons that providing QoS has been a great challenge in the past and it continues to be a hot topic as there is still a lot of scope to provide better service standards.

5.3 3G QOS Architecture
In order to have QoS functionality, it should be configured from the source up to the destination. The traffic moves from Terminal Equipment (TE) to another TE through all network services. The UMTS bearer services consist of two parts: Radio Access Bearer (RAB) and Core Network Bearer (CNB) services. These two services used to optimize the UMTS bearer service in a network topology taking into consideration mobility and mobility subscriber profiles.

The RAB service provides a secured transport of signalling and user data between MT and CN edge with QoS adequate to negotiated UMTS bearer service and with the default QoS for signalling. The RAB is based on the radio interface behaviour and maintained for moving MT.

UTRAN and MT have the ability to segment/resemble the user flow into different sub-flow requested by the RAB service. The segmentation/resemble is provided by the Service Data Unit play load format singled at the RAB establishment. The radio bearer service handle the part of the user flow belonging to one sub-flow based on sub-flow reliability requirements.

The CNB role is to efficiently control and use backbone network to provide the contracted UMTS bearer service. The UMTS packet CN support different backbone bearer services for different QoS.

The CN nearer service uses a generic network service. The backbone network service covers the layer 1 and layer 2 functionality and is selected according to operator's choice to satisfy the QoS requirements of the CN bearer service.

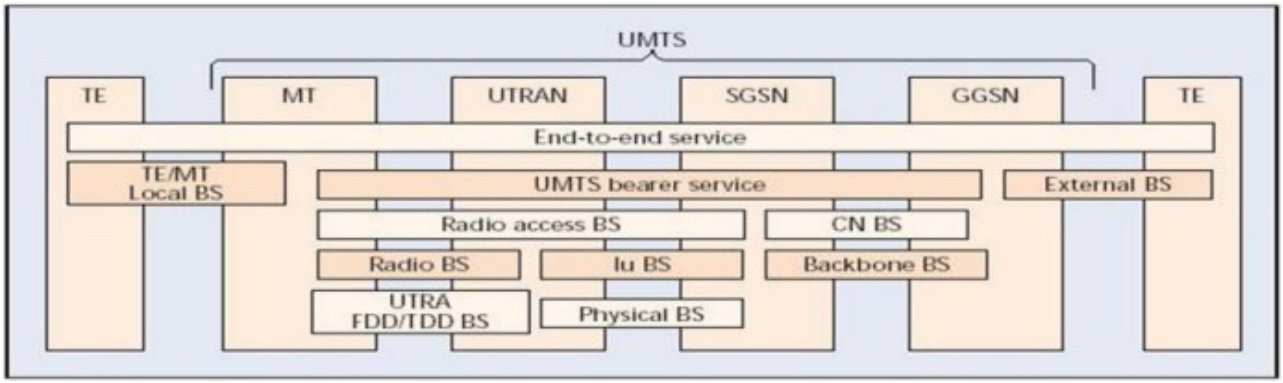

Fig4: Architecture of QOS

Quality of Service (QoS): Differentiation works by dynamically differentiating traffic when the Network becomes congested and enforcing policy rules based on time of day, device type, data volume, location and more. QoS differentiation ensures that the most time critical services and customers are served first. Nokia Siemens Networks offers QoS differentiation and unique application awareness using its comprehensive QoS differentiation capabilities that have already been deployed successfully in more than 20 networks.

6. Complex Architecture

6.1. Multimode End-User Terminals:

To reduce operating costs, devices that operate on 3G networks should have the capability to operate in different networks. This will not only reduce the operating cost but will also simplify design problems and will reduce power consumption.

However, accessing different mobile and wireless networks simultaneously is one of the major issues 3G networks have been addressing. One mechanism that has been proposed to handle this problem is termed "multi-mode devices".

6.2 System Discovery and Selection

Due to the heterogeneity of 3G networks, wireless devices have to process signals sent from different systems, discover available services, and connect to appropriate service providers.

Various service providers have their own protocols which canbe incompatible with each other as well as with the user's device. This issue may complicate the process of selecting the most appropriate technology based on the time, place and service provided, and thus, may affect the Quality of service provided to the end user.

One solution to resolve this issue is called "System-initiated discoveries". This mechanism allows automatic download of software modules based on the wireless system the user is connected to another approach to handle this problem is based overlay networks. In such case, the end-user device is connected to different networks through an overlay network.

6.3 Service and Billing

In the face of declining voice service margins, Communications Service Providers are investing heavily in deploying and marketing "3G" networks that are capable of supporting an ever-increasing variety of data services from streaming video, to gaming, to proprietary business applications, to mobile commerce transactions for tangible goods and services.
However, as 3G finally makes it into the mainstream, its success is inextricably linked to how the CSPs(Communications Service Providers) charge and bill for services in ways that are both intuitive and acceptable to the end user while also being relevant to the CSP's costs and billing capabilities.

7. Conclusion

UMTS stands for Universal Mobile Telecommunications System. It is a part of the International Telecommunications Union's 'IMT-2000'vision of a global family of' third-generation'(3G) mobile communications systems. Many think UMTS will play a key role in creating the future mass market for high-quality wireless multimedia.3G related work is still going on and Japan could be among the very first countries with commercial 3G roll out, as early as possible. The 3g have different types of revenue has been defined as the following: Single Voice, rich Voice, Location Based Services, Business MMS, Mobile Internet Access, Consumer MMS, Mobile Intranet/Extranet Access, and Customised Infotain.

8. How to improve 3G in future:

1. For better performance we have to make 3G as IP based which will allow higher data transmission rate.
2. We have to use only packet switching so that we can achieve higher internet speed eliminating circuit switching which makes internet speed slow.
3. To have the better performance we have to use OFDM technology with QPSK and 16 QAM modulation rather than simple QAM modulation technology.
4. The 3G should be integrated with the IP based technology so that it can have the tremendous data transmission and support VoIP as well.
5. We have to increase the band width of the 3G networks by using technology such as orthogonal frequency division.
6. If we are able to integrate it with the wireless LAN for better quality of service.

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