Technical Plans and Solutions for Smooth Migration of Toll and Tandem layers to NGN

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Summary
Next Generation Network NGN is a centric converged network aims to provide a multitude of services over a single integrated network infrastructure, rather than multiple separated and overlay networks, as have existed for decades. The deployment of NGN have brought unique challenges in how to deploy and implement the migration phases to NGN with the best scheme, lowest cost , fastest speed and minimum risks. Operators plan to migrate to NGN to simplify their networks, introduce new NGN services, and reduce CAPEX and OPEX. Network simplification is the most important step to widely and easily introduce NGN services. Operators are searching for a smooth, reliable, and cost-effective migration solutions without services impacts. Replacements the transit and the tandem layers will reduce the network complexity and facilitate the deploying of NGN services, however it is the most difficult step in implementation. This paper will present a detailed practical solutions and plans to smoothly migrate the tandem and toll offices to NGN. A detail cut over process with the necessary Precautions will be outlined. The results of migration the transit and tandem layers of Yemen Telecom legacy network will also be presented.

Key words:
Migration,NGN, Tandem ,Transit, servise Cut Over.

1. Introduction

Next Generation Network (NGN) is a packet-switched network providing a range of telecommunications services, which uses transport technologies for several bandwidths and classes of service, in which service related functions are independent of the underlying transport technologies. NGN covers multiple networks and layers. It is a means of providing services across a range of technologies giving users consistent and ubiquitous service provision, and unrestricted access to different service providers, with supporting general mobility. NGN provides a single platform and integrate the existing separated voice and data networks into a simpler and more flexible network based on IP protocols. The aim of the network operators in the whole world is to migrate their networks to NGN in order to benefit from the NGN features as well as to avoid the drawbacks coming from legacy network, beside other financial factors such as reducing capital expenditure (CAPEX) and operation expenditure (OPEX).Worldwide, NGN deployments still at an early stage , some operators are planning or still in finalizing their plans to go to NGN, other operators are started to migrate their PSTN to NGN taking different strategies based on their situations and conditions as illustrated in [1], beside other financial factors. In fact, all of the strategies aiming to reduce the network complexity, reaching to the NGN and make the network to be IP Multimedia Subsystem (IMS) ready .Since the legacy network consists of many meshed layers, one of the network migration goals is reducing the network complexity by replacing the tandem and transit layer by the NGN equipments. The implementation of replacing such important layers in a live network is very difficult and critical. Many preparations and plans should be done prior to the migration process. A good migration plan, implementation plan, cutover procedures plan, and roll back plan should be outlined and reviewed carefully for every site, otherwise an avoidable problems could be occurred. This paper will present a detailed practical solutions and plans to smoothly migrate the transit and the tandem switches, avoiding the possible risks and services interruptions. The presented solutions and precautions in this paper are considered as an optimal guides and references for networks planners, designers, and implementers. These plans and solutions are proposed to be used for the migration of YT transit and tandem legacy switches to the NGN .Section 2 will give an overview for the legacy network and the migration goals of the telecoms operators. Section 3 discusses the main points of the migration preparation and plans. The cut over process and implementation will be outlined in section 4. Finally the migration results of the transit and tandem layers of YT network will be presented in section 5.

2. Network Evolution

Network evaluation is the starting point for any network migration. Before planning for migration, design or implementation, the existing network should be evaluated. The evaluation could include operation support network, existing equipments and resources, services network, signaling network, bearer traffic network and synchronization network. According to the evaluation results a proper strategy, plan, and solution can be formed

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for further implementation. In addition, the Key Performance Indicator (KPI) of the existing networks will be kept and used as a benchmark for the performance of the new network. Migration of legacy networks covers the following stages. First, network migration from the old infrastructure to a new infrastructure. Second migration of the basic, supplementary and intelligent services. Third migration of all the related data such as OSS and billing.

Whatever the selected strategy is, it's goals should be ordered as follow: Reduce the networks complexity, replace the outdated TDM switches, and introduce new NGN services and achieved the condition outlined in [11]. Reducing network complexity to be only three layers instead of seven layers is achieved by replacing all the switches in the transit and tandem layers with NGN equipments. Simplifying the network make the deploying of the new NGN services to be easily deployed and not be tied to a specific location. However, the network complexity and the importance of the transit and tandem layers - because these layers represent the bottleneck of the network due to the huge traffic they carried - make the replacement of these layers very difficult and sometimes impossible. Operators are afraid on how to safely replace these very important layers without any impact on the network and services. The following sections will propose a technical preparation and solutions to replace the transit and tandem layers smoothly and safely, avoiding any possible impacts.

3. Migration preprations and plan

The most difficult part of the migration to NGN is the migration implementation and services cut over of both transit and tandem switches. The implementation should be carried out with a high degree of attention, accuracy and precisely, otherwise un-avoidable problems could be happened. The migration should be implemented in a smooth and safe manner, in order to reduce the impacts on the existing network, reduce the implementation cost, and get the benefit along the migration line. A good migration plan should be prepared prior to the migration and it should cover at least the following outlines.

- Network Migration plan
- Data migration planning
- Phases implementation plans
- Cutover process plans.
- Tests, Acceptance, and Operations plans.

After the network migration plan becomes ready, services and data migration plan should be prepared as well. The important point of the migration is to ensure that the services and data of the legacy network being migrated into the NGN system had been migrated correctly and timely. There are two types of data need to be migrated from the legacy switches to the NGN with a high degree of precisely and accuracy. They are static data and dynamic data. Static data are those data stored in each TDM switch and can only controlled and modified by the operators, such as subscribers numbers and profiles, charging data and so on. Dynamic data are those data that can be modified by subscribers such as USSD data. To guarantee the exactly and timely migration for the both mentioned types of data, a good plan and preparation should be started before at least two week of the migration night activity. The plan of the data migration should cover the following: Prepare all the data of the switch to be migrated to be NGN format. Prepare and check all the needed configuration scripts such as (Routing, charging, number processing, etc) before the migration action, otherwise the migration should be delayed for more safety. To avoid the manual mistakes, a conversion tool can be made by a good programmer to automatically convert the data of the legacy switches to the NGN format. Finally all the needed documents and items for tests based on the operators and vendors recommendations beside the tests items listed in [5], [6], [7], and [8] should be planed and prepared.

The following recommendations should be generally considered in the migration plan.

- Migration should fulfill the whole network topology and design.
- For an accurate plan, the updated on-site-survey reports should be taken in consideration to guarantee the space availability needed for the new NGN equipments.
- Estimation of the needed times, risks, and the suggested solutions.
- Test plans and test reports preparation for each site(i.e. environment, hardware, software, and functionality test
- Recourses planning and preparation. (Staff, Materials, Cars , Tools ,Supports…etc).
- Migration implementation plans.
- Integration with the live networks plan.
- Data migration plan.
- Integration with OSS plan.
- Integration with the billing system plan.
- Service swap and cut over plan and testing.
- Rollback plan and testing.

After the migration plan is finished by ,the project manager, the on-site switch supervisor or team leader, the head of the switches department, and the head of traffic department because they are the most peoples involved with the real situations and configurations of the sites. The plan should be reviewed by the higher managerial level together with a technical committee, and vendors to be valid. After that the migration of the site can be transferred to the next step the implementation, which is the most critical step. The following section will illustrate the most important technical and practical preparations that would guarantee a smooth migration without any impact on service or network disaster.

A. Migration Implementation preprations and activities.

The migration implementation to the NGN should be started by inspections and checking of the TDM switches data and situations. In general the preparation and implementation processes can be outlined as:

- Environment checking to guarantee the availability of the power sources, air-conditions, grounds, …..,etc.
- Preparation and transportation of the equipments, tools, and the needed resources to the site to be migrated.
- Hardware installation for NGN new equipments.
- Hardware inspection and acceptance test.
- Power on the installed NGN equipments, software commissioning, software inspection and testing.
- Functionality acceptance test.
- Integration and testing of the new NGN equipments with the live telecom networks according to the design.
- Integration and testing with billing, OSS, IN, and VAS (Value Added Services) systems.
- Ensure and establish a good cooperation with all the relevant network entities before cutover.
- Service and data swap and cut over with testing.
- Final test and acceptance.

B. Important Recommendations

The most important recommendations that should be considered during the implementation are as follow. The cut over should be done if and only if all the types of tests and inspections are totally succeeded. Cut over should be firstly tested and carried out on the trial systems installed before. The tests also can be performed by the migration of only a very few number of subscribers and trunks and monitor the functionality of the new system. If the cut over test pass, the rest of the migration will be held according to the plan. It is recommended to carry out a cut over with the presence of the supports of both the new and the old systems together with a good expat engineers to guarantee t fast help in case of facing some problems. In order to build good experiences, the cut over process in each site should be recorded carefully with all its actions and mistakes. These recorded actions will to be taken as a reference for the next coming cutovers. In case of the migration fails and not validated, the rollback is the only option. Enough time must be reserved for rollback. Below is the detailed proposed solutions to migrate the transit and tandem switches to NGN.

4. Migration of Tandem and transit layers

The most effective goal of the migration is to reduce the network complexity by replacing the tandem and the transit switches with the new NGN equipments as proposed in[9]. The equipment quantities and the needed resources is calculated based on the mathematical method described in [4,10]. Here are the two proposed practical solutions to replace tandem and transit switches smoothly and safely.

- Replacing the transit and tandem switch with NGN soft switches and MGWs using different SPCs(Signaling Point Code).
- Replacing the transit and tandem switch with NGN soft switches and MGWs using same SPCs.

The algorithms of both mentioned solutions will be described here for only one transit or tandem site.

A. Smooth replacement and cut over using different SPCs.

The following steps summaries the solution algorithm on how to implement the replacement of any tandem and transit switch to NGN using different SPCs.

- Install the new NGN equipments (soft switches & MGWs&..) according to the survey report and design.
- Carry out the necessary tests and inspections as listed in the plans.
- Configure the new softswitches as a transit offices with different SPCs. Configure all the data, to be the same with that one in the switch to be replaced. Including the prefixes, number processing, charging, signaling interworking data, and trunk data, and according to the NGN design documents.
- All the routes that was directed from the office to be replaced to the end offices, should be configured in the softswitch and re-directed towards the switch to be replaced.
- Several E1s for test should be configured between the switch to be replaced and soft switches and between the soft switches and the end offices. On the softswitches, configure routes to the end offices to be migrated. Insure, completing the prefixes data, charging data, and services data with some tests. Do direct call on two timeslots of each E1 circuits on both E1 halves, to guarantee no cross connections exists that may lead to silent calls. Test all types of calls as well.
- At cut over night activity the traffic can be stopped (generally at 00:00). Earlier as possible.
- Trunk interruptions and the deletion of the circuits between the switch to be replaced and the end offices should be performed.
- Trunks between the soft switches and the end offices should be added and configured.
- Temporary trunks should be configured between the soft switches and the old switches to be replaced. The numbers of these trunks depend on the capacity of the migrated end offices. It reaches the maximum when half of the subscribers are migrated.
- Migrate the services from the old transit office and the end offices to the NGN office. Then, perform some tests to insure the prefixes data, charging data, and service data are correctly migrated. Direct calls should be made on two timeslots of each E1s halves. More than one end office can be migrated at the same time. It is better to migrate around 120E1 per night - it depends on the resources availability - to be in safe situation.

- Monitoring, troubleshooting the problems that may appears. Bills verifications ,performance measurements, and checking of the migrated E1s , and calls statistics checking to ensure the calls success ratio, should be continue for one or two days after the cutover activity .
- Repeat step 4 through step 6. The traffic and services can be migrated as per end office until all the TDM end switches completely connected to NGN. For the cutover it is recommended that the end office which has low traffic and much idle E1 ports should be connected first to the NGN equipments.

B. Smooth replacement and cut over using the same SPCs

Another solution to smoothly replace the transit and tandem switches is to configure the new softswitches with the same SPC of the switch to be replaced. The algorithm of the solution is summarized in the following steps.

- Install the new NGN equipments (softswitches& MGWs&…) based on the survey report and the network design
- Carry out the necessary tests and inspections as listed in the plans mentioned before.
- Configure the new softswitches as a transit switch with the same SPC as the old switch to be replaced. On the softswitch, configure all the data, to be the same with that one in the switch to be replaced. Including the prefixes, number processing, charging, signaling interworking data, and trunk data, according to the NGN design documents.
- The multi-SPC function should be enabled on the softswitches. The interworking links and trunk data to connect all the end offices to the NGN should also be configured.
- The signaling links could be migrated during the day time (but not at busy hours) ,the signaling distribution should be considered. The link should be disconnected from the digital distribution frame (DDF), and reconnected to the MGW. After the link runs normally, it should be activated on the NGN and the end office. In this way, the link is migrated. In the old and NGN offices, check the link statistics and the Measurement results of the transit traffic. If the link statistics and measurement result of the transit traffic is correct, repeat step 4 to migrate the remaining links in the office direction. The priorities of the links didn't need to be changed when migrating the remaining links. Just, block or deactivate the links.
- After all the links in the office direction are migrated, the voice channels as per E1 should be migrated in the daytime. First, select the E1 to be migrated. Same as the link migration, block the E1 circuit between the old switch and the end office. Then, delete the signaling distribution data for the E1 circuits, disconnect the E1 from the DDF, and reconnect it to the MGW. After the circuits runs normally, activate the voice channel on the softswitch and the end office. In this way, the E1 circuits are migrated.
- Check whether the data of the migrated E1 circuits is correct in all related entities, traffic and statistic data can be used for help.
- Check the accuracy of the generated bills.
- If the migration of the first site correctly confirmed, repeat step 4 through step 7 to migrate the first E1 in other end offices. An observation on the status of the E1 should be carried for a workday. If everything is normal, repeat step 7 until all the E1s of the office direction have been migrated.
- Once finishing the migration all E1s of the end office, The related data of the services on the softswitch should be changed to migrate all services. After the softswitch handles all the traffic, the temporary E1s circuits between it and the old switch should be disconnected. Then, the tandem or transit office will be phased out. Considering the security of migration, migrate services per end office is preferred.

Finally integrate all the other networks entities and other operator's networks with the NGN, and then switch off the old

Table 1 Comparison between the Two Proposed Cut Over Solutions

Smooth replacement	**Risk**	**Resources**	**Service over**	**Time**	**Method Rating**
Smooth replacement and cut over using the same SPCs	Low	Lowest	Short	Shortest	Highly recommended
Using Different SPCs	Medium	Medium	Medium	Medium	Recommended

transit and tandem layers. The comparison results between both the above proposed solutions are shown in Table 1.When the replacements of all the transit and the tandem switches is achieved, delete the temporary data by referring to the overall network design. The resulted network topology will be as shown in Fig.2, which is a simple network. All local end switches nodes will be served by the NGN network so; the introduction of the new NGN value added services can be achieved easily, widely and with minimum cost.

5. Case Study: YT network Migration to NGN.

Yemen Telecom YT is the incumbent telecom operator in Yemen that offering fixed voice and data services for all over Yemen. It has two separated networks one for voice and the other is for Data. The majority of switching technology used is TDM switching. YT decided to start the

migration of its' legacy network to NGN. The best Migration scenario for YT which is a hybrid scenario that combined from the PSTN replacement and NGN overlay strategies as proposed in [9]. It aims to achieve smoothly and economically migration to NGN with low cost and minimum risks , saving traditional business , focusing on customers' needs and getting a target network that could be evolved in the future to a full IP Multimedia System (IMS) architecture. So NGN should be achieved in phase manner. The replacement of PSTN will be done for transit and tandem layers with two soft switches, six MGW, two HLR , and some AGWs as the first phase. All the solutions, plans and percussions presented in this paper is proposed to be used to migrate Yemen Telecom legacy networks to the NGN.

Before we present the results of the first phase of YT network migration, YT legacy network architecture will reviewed first.

A. *YT legacy network:*

Y.T legacy network consists of five TDM switching layers International, Transit ,Tandem, local ,and access layers as shown in Fig. 2.

International Layer: Contains two international gateways used MGWs and soft switches. This layer is managed and operated by another company.

Transit Layer : Contains two TDM exchanges installed in the capital (Sana'a).This layer offers interconnection to tandem

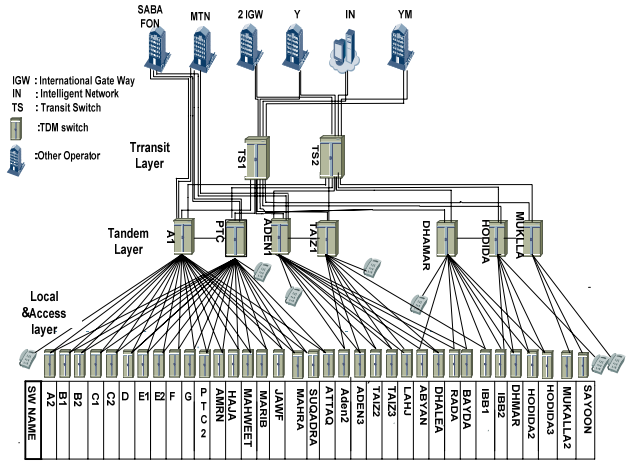

Fig. 2 Yemen Yelecom Legacy Network Topology

switches and interconnect them with international layer.

Tandem Layer : contains seven TDM switches offering Intraregional switching between local exchanges and interconnecting all regional traffic to and from transit layer .

Local Layer: contains forty two TDM switches with the lowest functional level of exchanges. The main role is to offer access and local switching to subscribers. Local level switches are connected to tandem Level exchanges.

Access Layer: Contains of 576 Subscriber Units (SU) distributed through 250 sites. And 53 main Optical Line Carrier (OLT) using V5.2 . The access layer is distributed in the rural areas .

In the existing topology each local switch is connected to two tandem switches, similarly, each tandem switch is also connected to two transit switches.

B. *YT First phase implementation :*

Based on the selected scenario proposed in [9] to migrate YT

legacy network to NGN. The first phase of YT network migration is decided to be as follow :

- Replace the 2 transit and the 7 Tandem switches with 2 soft switches , 6MGWs , two SHLRs , and some AGWs to serve the PSTN subscribers of the replaced switches. The equipments quantities were decided based on the calculations method mentioned in[4.10]
- Connect the 6 MGWs to the local switches to be served by the soft switches and at the same time connect the MGWs to the other operators network as well .

All the plans and solutions presented in this paper are prepared and written to be used for the implementation of replacing the two important layers of YT. The result of this phase is a simple network with a topology shown in Fig.3. The NGN new services can now deployed easily. Replacing the outdated local end switches become now easier.

6. Conclusion

Network migration is a comprehensive project, involving a very complex implementations to guarantee end-to-end services delivery. In

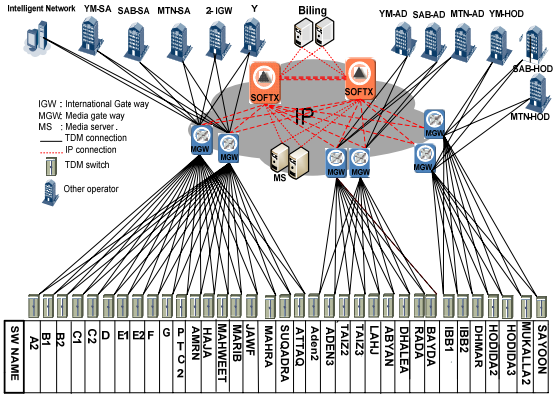

Fig.3 Yemen Telecom Network after the First Phase of Migration

its long term practice, operators are decided to simplify their networks by replacing the transit and tandem layers with the NGN equipments, however they are afraid from how to implement this step. The proposed solutions and

plans presented in this paper simplify the implementation of replacing both transit and tandem layers of the legacy networks. Two technical and practical solutions are proposed for replacing the tandem and transit layers either using the same or different SPCs. Taking these solutions and plans as our guides to
replace YT transit and tandem layers, help to achieve a smooth migration without any impact on the network. Focusing on the pressures and challenges faced by operators to implement the whole project and cut over's, a technical solutions methodologies , migration plans, and the necessary precautions that has proved to be effective is proposed in this paper.

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