Network Infrastructure Discovery - Streamlining complex developments with parametric approach in MTOSI compliant fashion

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Abstract - For any type of highly automated fulfillment systems – key success factor for efficient service provisioning is quality of data in inventory.

Almost every service today is of complex nature and spans over multiple types of technologies consisting of different equipment types, management systems, vendors.

During previous years maintaining data accuracy was complex and expensive manual task. However by introduction of network discovery capabilities in Croatian Telekom NGOSS infrastructure – quite lot of this task could be automated. This paper is presenting key challenges and how they were overcomed with several significant original innovations that made this solution implementation successful as result of cooperation between Croatian Telekom and GDi GISDATA.

I. INTRODUCTION / STANDARDS

Croatian Telecom and GDi GISDATA are TM Forum members for number of years and extensively use Frameworks, Best Practices, or Guidelines defined by TMF. In this section we will mention key recommendations.

A. eTOM - TM Forum Business Process Framework [1]

The Croatian Telecom's NGOSS architecture reflects major elements of the operations side of the Business Process Framework. In 2003 legacy mainframe based inventory and design system (TIS) was replaced with a true Resource and Service Inventory solution (Telcordia Granite Inventory). According to eTOM that was first component of so called Resource Layer, including additional modules for Service Provisioning and Activation (Telcordia Activator), Discovery and Reconciliation (Telcordia Discovery) and Outside Plant (GE Smallworld PNI).

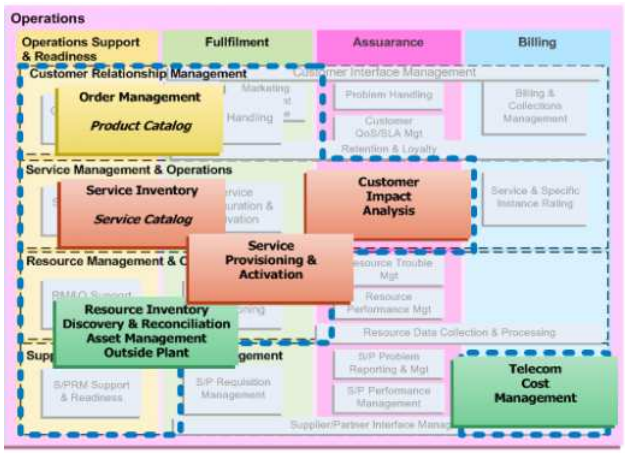

Figure 1: eTOM – TM Forum Business Process Framework

During 2009/2010 further component where introduced and creating of a true Service Management Layer was completed. At the center of the Service Layer is a Telcordia Dynamic Services Catalog with specific constructs for Customer-Facing and Resource-Facing service templates. This creates heart of Croatian Telekom Catalog Driven Order Management solution [9, 10].

B. SID - Information Framework [7]

Croatian Telekom makes use of TM Forum's Information Framework common language to accurately describe various business entities engaged in the process of end-to-end service delivery.

Croatian Telecom physical and logical data models are Information Framework compliant and cover both the standard objects and relationships – implemented in Telcordia Granite Inventory S/RM database. Telcordia adherence to the Framework's common language proves crucial for multiple

interface integration and facilitated data modeling, and taking in the consideration OPEX costs, proves crucial for cost-effective business transformation.

The Croatian Telecom has leveraged this native alignment with the Information Framework to make their Discovery and Reconciliation implementation more closely aligned with industry data models (e.g. MTOSI format used in Discovery Adapters development).

C. TAM - Application Framework [8]

The Croatian Telekom general application of Business Framework (eTOM) in its business transformation lends itself to implementing elements of Application Framework (TAM):

- Service Order Management (implemented using Dynamic Service Catalog and Expediter OM) as part of Fulfillment
- Resource Process Management (across OS&R, Fulfillment, and Assurance) under workflow control – implemented using Expediter
- Resource Inventory Management (across OS&R, Fulfillment, and Assurance) - Implemented using Granite Inventory, Discovery and Activator

The utilization of TM Forum's Applications Framework [2,3,4,5,6] allowed for effective classification of legacy applications by mapping their roles to Application Framework's components. It also facilitated design migration and integration strategy development – in the end leading to BPM and application separation into "native systems" and "cleaning" existing applications from modules that where temporarily introduced. Good example is removing activation capabilities from Work Force Management System and moving to service fulfillment dedicated system - Activator.

II. CROATIAN TELECOM NGOSS ARCHITECTURE:

Changing markets, increasing competitive pressures and evolving customer needs are placing greater pressure on IT to deliver greater flexibility and speed. Today every organization is faced with the need to predict change in a global business environment, to rapidly respond to competitors, and to best exploit organizational assets for growth. In response to these challenges, leading companies are adopting service-oriented architecture (SOA) as a means of delivering on these requirements by overcoming the complexity of their application and IT environments.

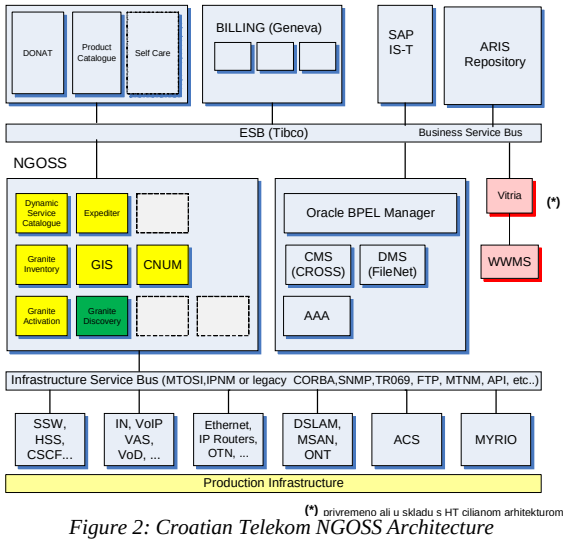

Figure 2: Croatian Telekom NGOSS Architecture

SOA represents a fundamental shift in the way new applications are designed, developed, and integrated with legacy business applications, and facilitates the development of enterprise applications as modular business services that can be easily integrated and reused.

Considering all above and you stated requirements, Croatian Telecom is using SOA as a main architectural style. Among many other SOA brings these benefits:

- Enabling SOA based infrastructure to share the information with enterprise wide business segment and support new business concept as a add on functionality
- Plug in driven IT infrastructure to reduce TCO
- Easy to integrate new applications
- Unlock the potential of existing legacy applications
- Provide flexibility across the business
- Simplifies Retirement and Replacement of Functionality
- Constructs Reusable Components

This approach is clearly depicted in Figure 2. that is representing current Croatian Telekom NGOSS architecture.

Besides its SOA orientation, current system architecture consists of two service buses. First one is business service bus and it's some kind of general purpose bus, which connects customer oriented services to system services. Second one is more specific bus which connects system services to resources and using MTOSI whenever possible.

In this way Croatian Telecom has better fit to already discussed TMF NGOSS standard architecture:

- Customer Management Plane

- Service Management Plane
- Resource Management Plane
- Adapter Plane

Presented high level architecture is clear and enables HT gradual transition towards fully integrated NGOSS leveraging existing investments in NGOSS and going towards “evolution” and not “revolution” in system implementation.

III. DISCOVERY & RECONCILIATION PROCESS

In general Discovery is part of so called Data Integrity Lifecycle where key targets are:

a) Recovery of stranded assets
b) Fraud Management Detection / Revenue Contribution
c) Reduction in Fallout Rate

Those targets are typically achieved using dedicated discovery and reconciliation solutions that have following functions (as depicted in Figure 3.):

1. Discovers or imports Network Data and normalizes it into a common format
2. Analyzes data across NEs, to combine it (i.e. into an end-to-end Path)
3. Compare Network Data against Service and Resource Inventory; identifies all discrepancies and suggests ways to resolve discrepancies
4. Update Inventory Database to resolve discrepancies

Or when more formally described:

1. Discovery process starts with job execution which can be either scheduled or manually started on selected piece of equipment (or equipment group) or EMS for all devices managed by the EMS
2. Discovery application enhance the request from inventory defined data where Adapter destination and Adapter name is defined as long with some arbitrary and adapter specific parameters. After enhancement, the request is forwarded towards Adapter request JMS Topic in form of MTOSI XML.
3. Specific adapter (selected based on the name) that listens on Adapter request JMS topic process the request and with interaction with EMS and/or network device forms MTOSI based XML response that is sent back to Discovery application on Adapter response Topic
4. Discovery processes the MTOSI response, it transforms it into more suitable XML format for Inventory compares, it executes match process towards inventory on all levels (all objects and all object details) and forms the list of discrepancies
5. The list can be either presented to the user so the user can choose whether or not to execute Inventory updates, or the list can be automatically sent towards Inventory (there is possibility to filter automatic discrepancies based on some of attributes)

In next section we would like to focus on Adapter side of Discovery process.

The request is sent by Discovery application towards Adapter in MTOSI form. Alignment with MTOSI format [11] ensures that requests are telecommunication technology or topology independent. The process explains Discovery for equipment hierarchy, but in the same manner it is possible to do physical connections discovery or some logical layer discovery.

MTOSI standard within *getInventoryResponse* method defines responses which are telecom technology independent. Furthermore, more and more network equipment vendors implement MTOSI APIs on their devices and/or EMSs. In that case (if there is MTOSI *getInventoryResponse* already implemented) the adapter layer is not necessary i.e. the implementation of that layer is trivial. As the real telecom operator has various types of devices of various generations and such heterogeneity is especially stressed up at incumbent operators, Adapter layer in this kind of architectures can be very complex, therefore new, parametric approach could be helpful.

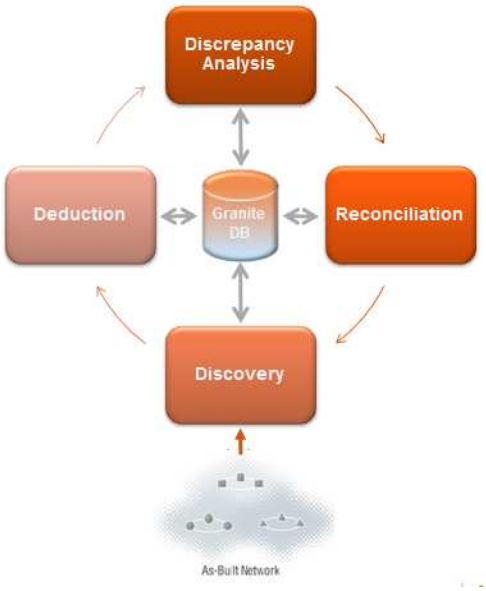

Figure 3: Typical D&R process

A. *Adapter layer*

Adapter is J2EE application that is deployed on J2EE server as MDB (Message Driven Bean). It's an application that listens for requests on Adapter request topic and writes response to Adapter response topic which is listened by Discovery application. As there can be multiple adapters that listen the same Adapter request topic, based on adapter name selection (which is sent as JMS Message parameter) the right adapter will be executed. In meanwhile (from the moment the adapter receives the request and interprets it to the moment of sending the response) the adapter needs to collect the data from the network. As traditional MDB, Adapter needs to be developed in Java, packed in ear archive with all corresponding deployment descriptors and deployed inside J2EE container. Adapters usually have to connect to various sources using different technologies (e.g. to EMS for some kind of data using HTTP and to network device using SNMP). Different variations of some network devices provide different outputs. Also, set of data that is included in Discovery process is subject to change from telecom operator side.

Because of all of that, it was necessary to abandon traditional J2EE architecture of adapter and to adapt new Adapter architecture which provides more agile approach – and this is main idea of this paper.

For that purpose, part of Adapter functionality is pulled out of ear archive and implemented using Apache Jelly open source project. That part is stored directly on server in form of Jelly XML scripts and XSLT scripts which are both XML documents. Such adapter configuration provides more flexible approach and enables rapid development process of an adapter.

Jelly script is XML which in Jelly context can perform various operations. With modules that come out of the box, GDi GISDATA additionally developed some modules that enable Jelly to connect to network devices using SNMP or CORBA in certain cases.

1) *Adapter sample for Juniper devices*

Network data from Juniper devices is collected using SNPM protocol from the devices, using XML API (JunoScript) that is enabled on each of the devices and Performance management system. The Figure 4. shows scheme of GDi Juniper Adapter.

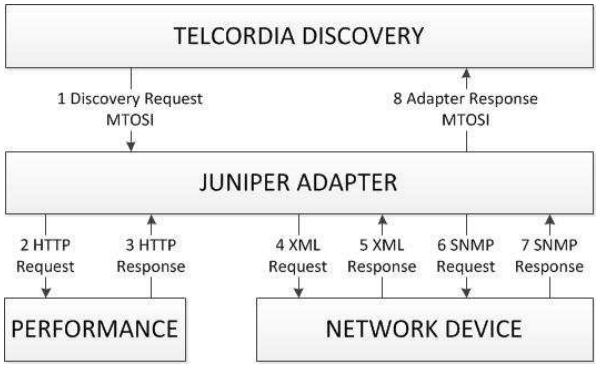

Figure 4: Discovery Adapter interactions

Adapter receives in MTOSI request message the name of the device that needs to be discovered. First the Adapter goes into Performance system using HTTP to collect connection parameters for SNMP and XML session.

The whole process is defined in Jelly scripts and can be explained in following steps:

1. connection parameters for XML and SNMP protocols are collected from Performance system and put into Jelly context
2. XML session is opened towards the device trough which basic hierarchy of the device (slot/card) and table of ports are collected
3. with additional script, the ports are mapped to corresponding cards
4. new SNMP session is opened towards the device to get **IF-MIB:ifXTable** and **IF-MIB:ifXTable** (SNMP data is transformed into XML form)
5. Jelly runs XSLT transformation to join XML based data and SNMP based data
6. Jelly runs XSLT transformation to form destination structure (slot/card/port) from witch Adapter constructs MTOSI response

All explained steps are implemented inside scripts which can easily be changed without need of build and deploy of application. Also, when the change is applied in the script, it becomes executable immediately. Furthermore, all steps can be easily tested on local development environment (MTOSI request and response can be simulated) which brings additional advantage comparing with J2EE application testing.

IV. FURTHER ENHANCEMENTS OF DISCOVERY PROCESS

As discovery process is very CPU and memory demanding since there are a lot of data that have to be compared and reconciled in numerous of discovery jobs, it's necessary to optimize the process in manner to discover as soon as possible

all possible discrepancies and to continue the process only with those discrepancy data.

To achieve that goal, a change in architecture has to be done. Instead of using adapters just for a network side of discovery, we need adapters (or connectors) for Inventory side as well. In that case, in the same time it would be possible to send two different MTOSI requests, one towards the Adapter for network discovery result, and the other towards Inventory for Inventory database result. Such two MTOSI results can be compared before any further transformation and find only discrepancies. The process than can continue with only those discrepancies.

If there are a lot of changes after every job execution that has to be updated into Inventory database, it is shown that standard Inventory API is not performing well for such large data volume. As the Inventory API is very generic and it implements a lot of logic that is not needed and not used in Discovery process, the enchantment can be achieved by implementing new Discovery restricted API that would be optimized for Discovery data manipulation in Inventory database.

Current Discovery application is developed and deployed as J2EE application inside J2EE container. The experience shows that for some very long durable jobs J2EE container is not very friendly environment. It requires a lot of custom configuration and the whole process is very hard to track. Complexity is further increased if Adapter layer is deployed on different server. Such architecture has to be set in environments in which network devices are divided in special network behind a firewall which is the most common case in telecom operator. To solve those issues, Discovery application should be deployed in new Discovery based architecture which can handle very durable jobs easily, outside of traditional J2EE containers.

Further enhancements needed in performance and scalability domain:

- Support for Multiple Managed Servers
- Clustering Support
    - vertical clustering (within a given node / process)
    - horizontal clustering (across multiple managed Servers / machines), by creating one domain across multiple machines
    - Queues and Topics will support clustering
- Scalable number of concurrent jobs
- Discovery & GAF in one managed Server, preventing queues in between
- Adapters on a different managed Server
- Throttling Support
    - On a per adapter base
    - Network delay on one Network Element shall not impact other Network Elements served by the same adapter (different adapter thread) or Network Elements served by different Adapter
- Single Sign-On
    - Standalone Sign-On, Single-Sign-on, Shared Sign-On
- GUI / Usability Enhancements
    - Propagation of Job Status Information (into Job History)
    - Configurable email notification (depending on job results)
    - Daily scheduling option
    - Enabling / disabling (periodically) scheduled jobs

V. SUMMARY AND CONCLUSIONS

In Croatian Telecom, TMF industry-standard specifications bundled with COTS solutions and targeted development successfully reduced delivery times, enabled fast service introduction, and consequent integration cost reductions. Key achieved benefits during last year's NGOSS transformations Croatian Telekom are:

• Reduced number of systems in the fulfillment chain. They managed to unified Resource and Service Inventory that holds all as-built and to-be inventory data. This has driven down costs and assured efficient organization.

• Due to Discovery capabilities implementation number of errors in provisioning chain has been significantly reduced. Reporting on discrepancies capability has been also improved.

• Vendor lock-in avoided: The use of TMF specifications and methodology reduced the Organization's dependency on vendor's specific solutions. Since all new NGOSS integrations use standard object definitions and standard protocols, the organization can now replace any system with reduced impact on the overall operation, thus minimizing integration risks. Having Discovery capabilities that are based on standards and not technology vendor dependent is resolving quite significant amount of problems

• Modular and flexible, future and change-proof solution introduced: Standard Telco practices have to be flexible enough to incorporate the Croatian Telecom special requirements. SOA, MTOSI and OSS/J (parametric) approach implies higher level of efficiency and flexibility to create

interchangeable component integration, introduction of new technologies is straightforward - while greater scalability ensures minimal impact to existing systems.

• Knowledge dissemination and training optimizations achieved: Having unified Discovery and Reconciliation approach to all technologies utilized in Croatian Telekom network infrastructure (possible as they have unified service and resource inventory) significantly improved operators' knowledge and understanding of network infrastructure reality and simplified training efforts when new technologies are introduced.
Further enhancements include plans broadening number of covered technologies and further improving performance.

Finally, the openness of the standard helps the Croatian Telecom to own the solution themselves. Relying on the TM Forum-based consolidated solution and using TM Forum specifications, the Croatian Telecom gets a clear understanding of what to look at when deciding to introduce new service or new network equipment.

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