VIEW POINT

NETWORK ENGINEERING OPERATION OPTIMIZATION

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Contents

1. Glossary

Abbreviation	Full Form
BSS	Business Support System
DD	Detail Design
HLD	High Level Design
LEX	Local Exchange
NEO	Network Engineering Operations
OSS	Operation Support System
UNESCO	United Nations Educational, Scientific and Cultural Organization
DWG	Drawing
UDF	User Defined Function
JPA	Java Persistence API
GEO	Geosynchronous Earth Orbit
OGC	Open Geospatial Consortium
GDAL	Geospatial Data Abstraction Library
GIS	Geographic Information System
CRUD	Create read update delete
ROP	Remote Optical Platform
OFP	Optical Fiber Packaging
RAAS	Rule as a Service
IDAM	Identity and Access Management
ERP	Enterprise Resource Planning
PMT	Project Management and Tracking
TMF	Tele Management Forum
ODA	Open Digital Architecture

2. Abstract

Communication Service Providers go through network transformation/modernization periodically. With the passage of time, the old technology/hardware becomes irrelevant and need to be replaced with latest technology/hardware to provide better experience to the consumer. Now a days there is need to upgrade the existing network infrastructure from Copper based network setup to Fiber based network setup. There are lot of manual sequential steps involved in network transformation, starting from designing of network till activation which delays the overall network upgradation. To bring agility to network transformation, CSP's must explore automation opportunities across different manual processes involved so as to achieve faster turnaround for the network transformation. In turn, this can help telecom provider to gain significant foothold in dynamically changing telecom industry. Approach shared here, can be adapted for Utility operators as well.

3. Audience

- CTO organization within CSP
- Program Managers, Architects, Consultants associated with Network Transformation.

4. NEO Challenges

Operation and Business functions in **telcos** are segregated as **OSS/BSS**. **Physical network design** is part of **OSS**. **Physical network design** includes the **HLD** and **DD** of the **network** so that:

- A new **greenfield** area can be made ready for **service activation** post laying of **network**
- **Network** can be upgraded (from Copper to Fiber) in **brownfield** area so that it is possible to serve **additional customers** in the area or **upgrade** service of **existing customers**
- **Fault** can be repaired for **existing customers**

Design and **laying** of **network** is **NEO** (Network Engineering Operations) team's responsibility.

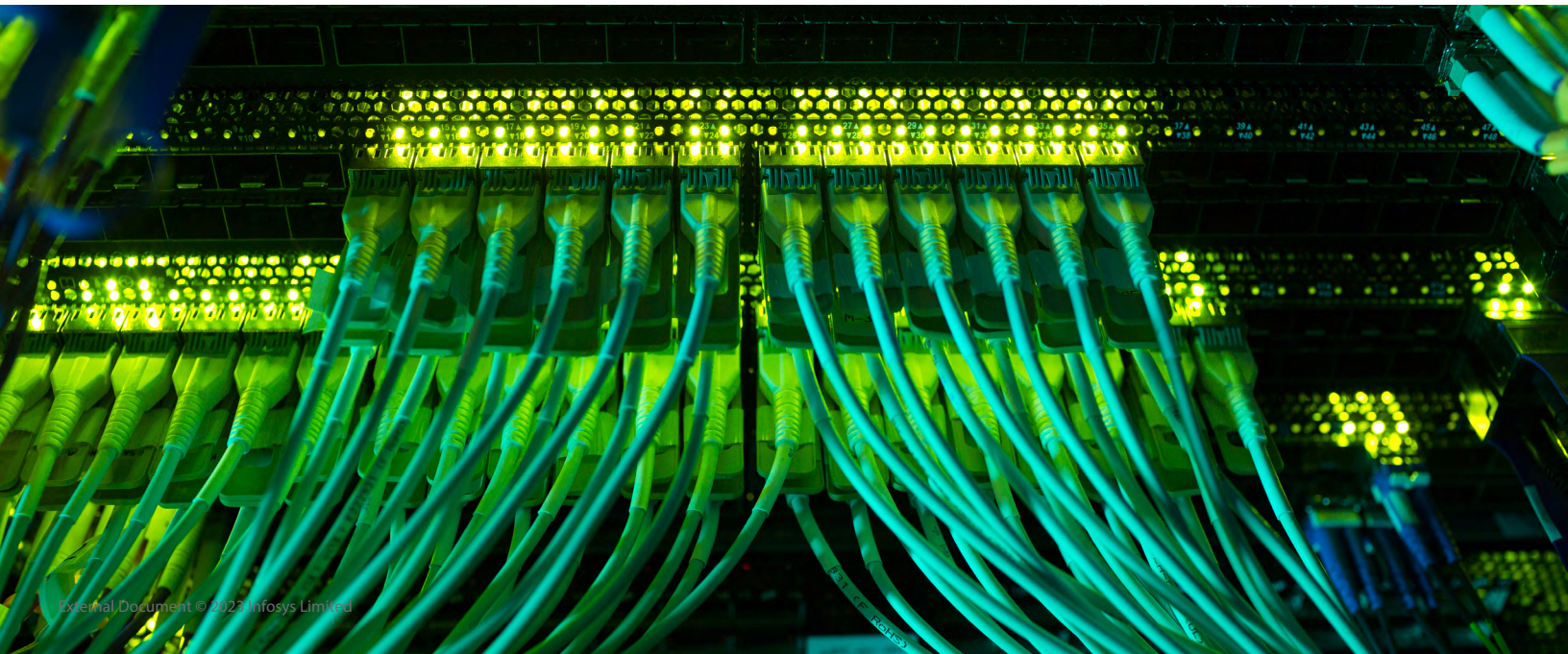
- It is one of the most **time-consuming** activity due to
  - Manual and **sequential** activities
  - **Frequent** change in existing **infrastructure**
  - Presence of infrastructure **documentation** across multiple IT systems
  - **No automatic** synchronization between infrastructure **to be developed** and **existing** Infrastructure
  - **Duplication** of effort in creation of **redlining documents**
  - **Recalculation** of cost due to **infrastructure** changes
  - No tool to **trigger** and **automate** conversion of **physical infrastructure** from **old** technology to **new** technology
- It causes significant delays in **network transformation** and increases **turnaround** time for customer, hence eventually leading to revenue loss corresponding to delay in turn around or losing customer due to dissatisfaction.

5. Opportunity for NEO Transformation

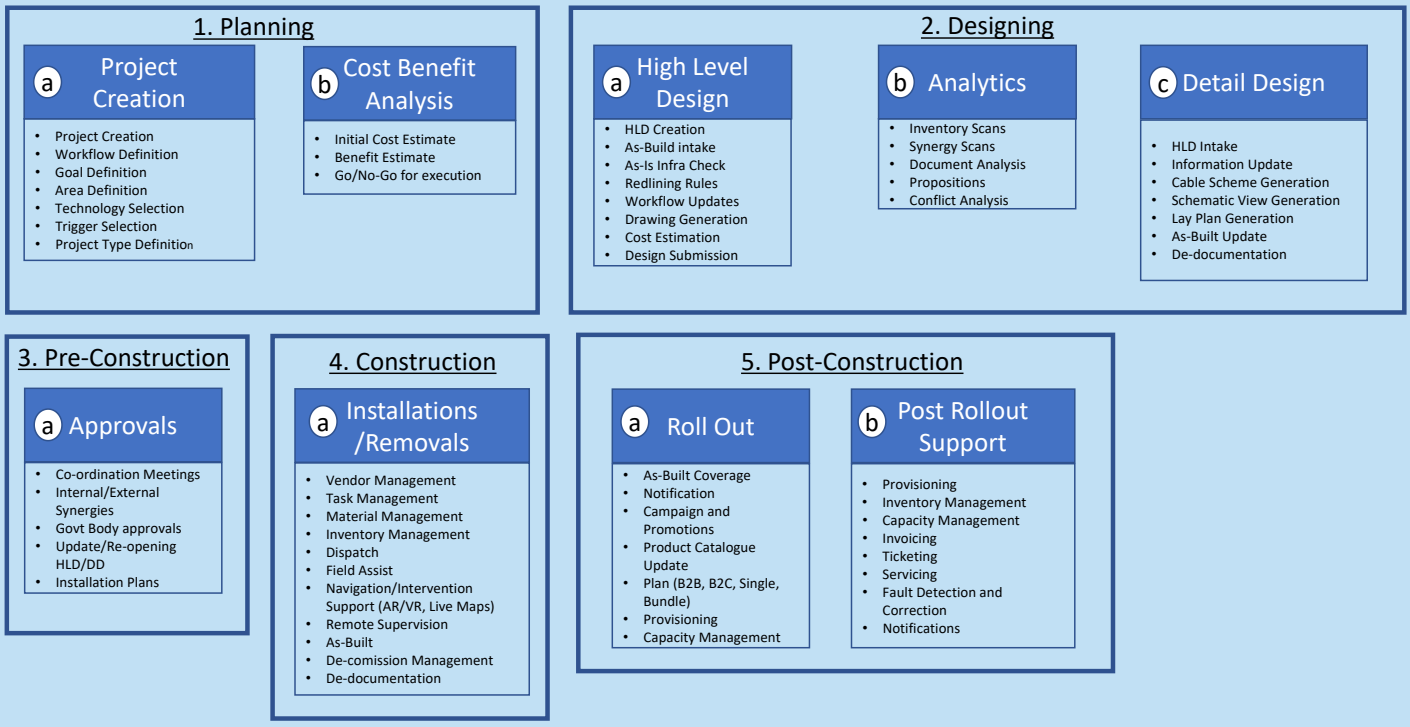
Many operators are adopting 5G, however it's potential can be realized only with fiber backbone. **Network transformation** is one of the key themes for **telcos** to stay relevant in dynamically changing environment

NEO is a key **OSS** capability which needs transformation to provide necessary agility in new **network rollout** and **repair** of **existing** network

NEO **challenges** need to be **mitigated via automation**. Hence there is strong need to **semi/fully automate** the different manual processes required in **network engineering operations**. This will in turn help **telcos** achieve the main goal of being able to **rollout new technology faster** and remain **ahead** of the competition



6. Network Engineering: End to End Process



Overall network engineering is categorized into following phases

Planning:- In planning phase, two type of tasks are executed

- Project Creation
- Cost Benefit Analysis.

In "Project Creation" task, following activities are taken up: -

- Identify the area and create the project covering it.
- Workflow definition in the BPM tool. This includes all the different processes which need to be executed to perform the network modernization
- Linking of goals with the project. These set of goals act as tiebreaker if the cost benefit analysis concludes that the project is not financially viable. (e.g. replacement of network and migration from UNESCO area to general area etc.)
- Technology selection identifies which technology will be used by this project like Copper, Fiber or Wireless etc.
- Triggers selection determines triggers which initiated this engineering project. It also has implication on approval of the project

In "Cost Benefit Analysis" task, following activities are taken up: -

- Ball Park cost of the project is arrived at based on perceived bill of material and other fixed/subscription-based cost
- Perceived financial benefits in long term and short term are determined. Strategic benefits of the project are also listed at this stage
- Cost Benefit Analysis is done for project, if the cost is more than benefit then project is abandoned. Otherwise, project design phase is initiated.

Designing:- in designing phase, two type of tasks are executed:-

- High Level Design
- Detail Design

In the "High Level Designing" task, following activities are taken up:

- High Level Design of project is created
- As-Is Inventory is retrieved for the project and synchronized during/post redlining
- As is infrastructure analysis is done to determine the updates
- Actual placement of infrastructure based on redlining rules
- Identification the opportunity for de-documentation
- Update workflow of design based on changes in the upstream and downstream systems

- Calculation is done to determine the project cost.
- Document generation for internal/external meetings
- Design is submitted to the detail design system

In "Detail Designing" task, following activities are taken up:-

- Intake of High-Level Design
- Detailing of the infrastructure by updating Information
- Cable scheme is generated
- Schematic view and lay plan generation
- Submission of design for further processing

Analytic tool helps network designers to identify where they can make intervention for designing. It is used in both HLD as well as DD phase.

Pre-Construction:- In pre-construction phase, approvals from the government bodies are secured and synergies with internal teams and external companies are made. So that build plan is generated and passed on to construction phase

Construction:- In construction phase, new network infrastructure is laid and existing one is updated as per design. Following activities are taken up in this phase: -

- Vendor management is done so that appropriate vendors are assigned for material, construction etc.
- Tasks are defined at the granular level to enable the tracking of construction and verification post construction
- Management of material and inventory is done
- Management of execution and dispatch by field worker is done, to ensure that tasks are done in order
- Supervision management is also done, so that once task is completed it is supervised using humans and bots
- Trigger to initiate de-documentation and retirement of unused infrastructure is done

Post-Construction:- In post-construction phase, two type of tasks are executed

- Roll out and
- Post Roll out support

In "Roll Out" task, following activities are taken up:-

- Coverage area and coverage location check
- Campaigns and promotions using various channels including cross sell and up sell
- Product catalogue and plans update
- Capacity management and actual provisioning of last mile

In the Roll Out support task, following activities are taken up in addition to the activities taken during Roll Out:-

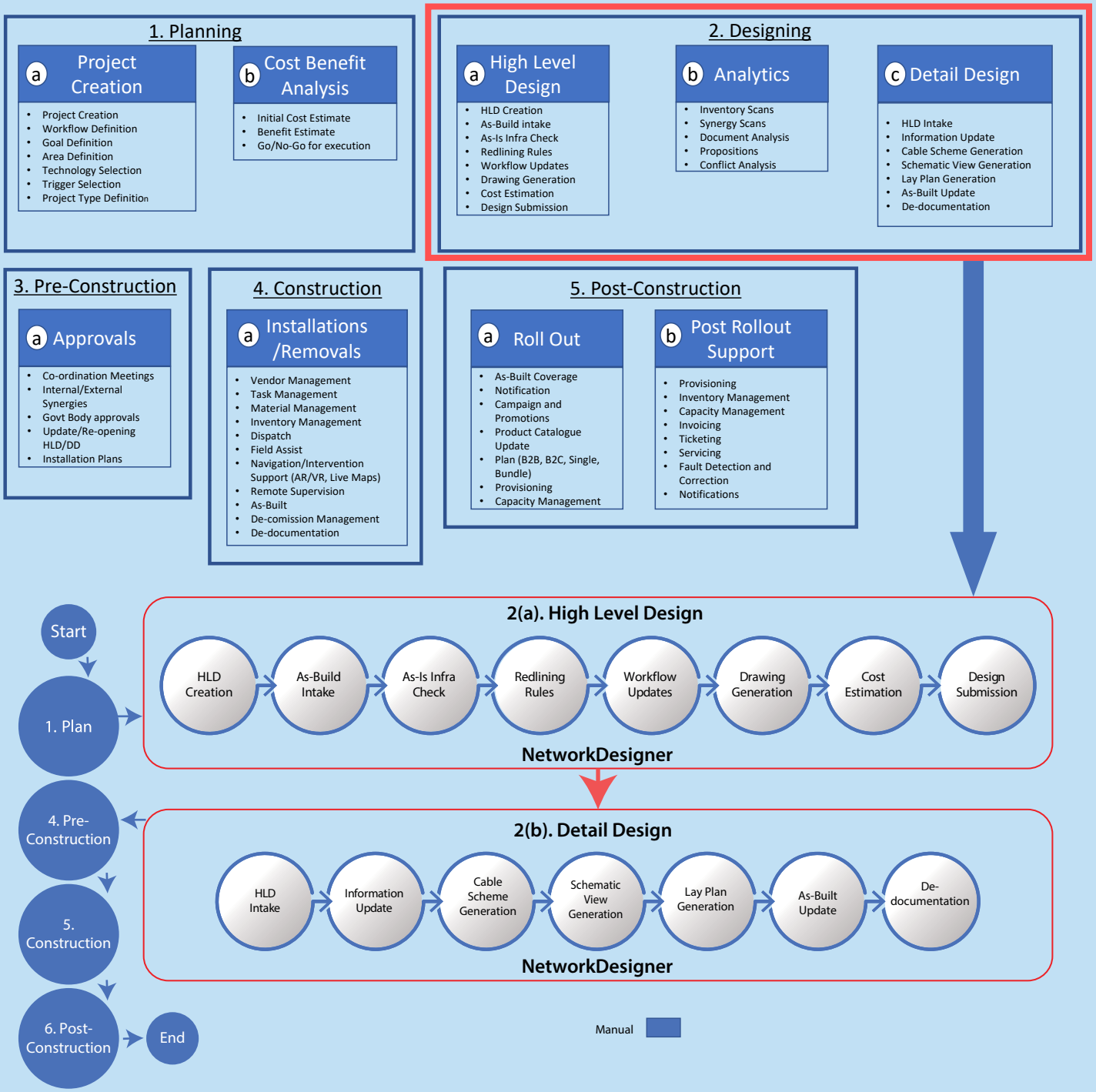
- Invoice generation and charging for customer
- Ticketing using different modes viz. Store, Email, Phone, Application etc.
- Servicing using different modes viz. Store, Email, Phone, Application, Technician etc.
- Fault Detection and Correction
- Notification system

Our focus area of implementation is bringing optimization in network rollout by optimizing the physical network design. It is achieved by identifying and automating the network design process as explained in the next section.

7. NEO: Automating Network Designing Processes

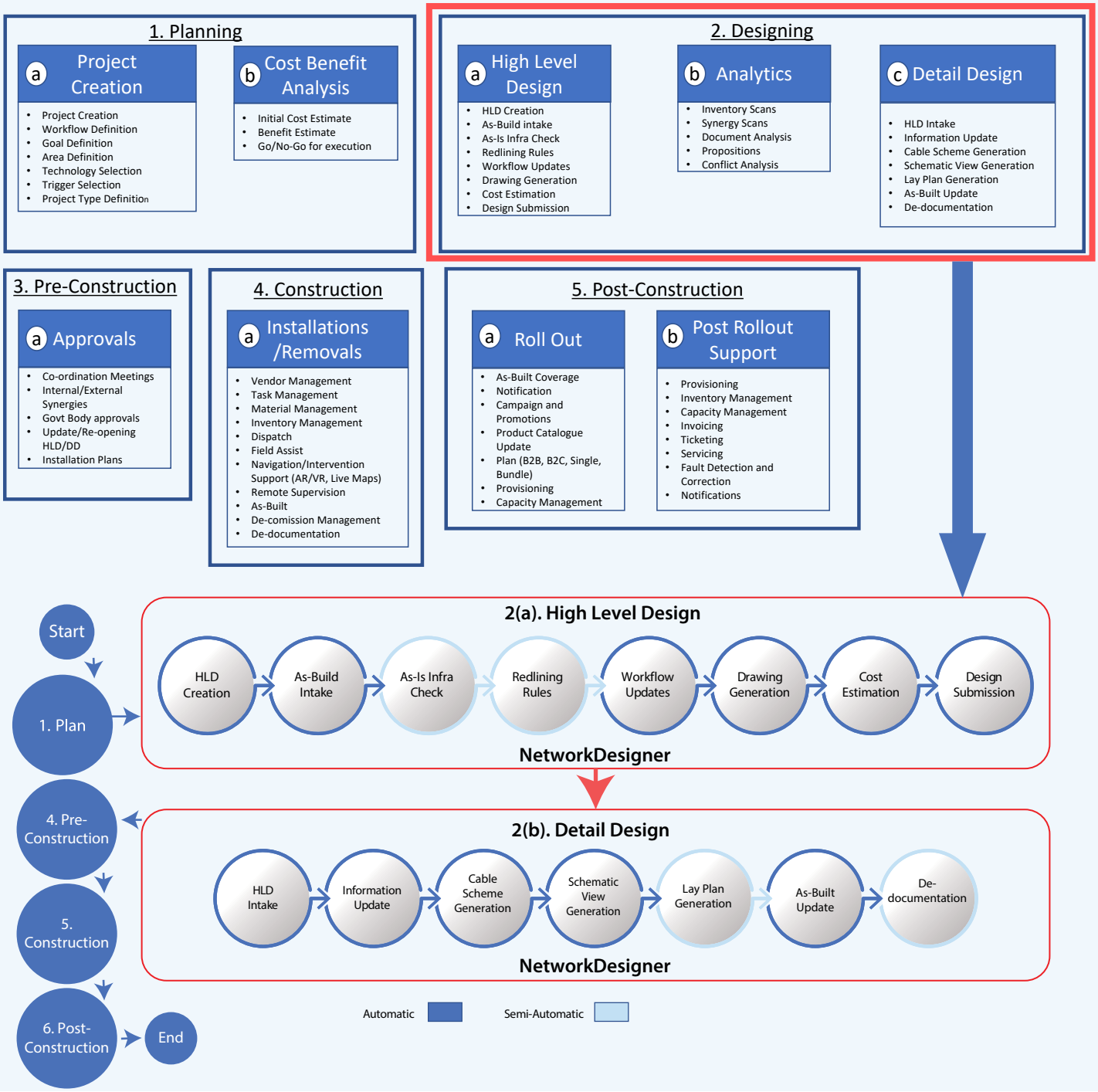
7.1 Traditional Approach

Below process flow depicted the traditional approach. There are lot of manual processes in the traditional approach of designing as per below diagram.



7.2 Digitization of Process

Manual processes are analyzed and automated as per feasibility and cost benefit analysis. Below process flow depicted the digitization of NEO processes in design phase.



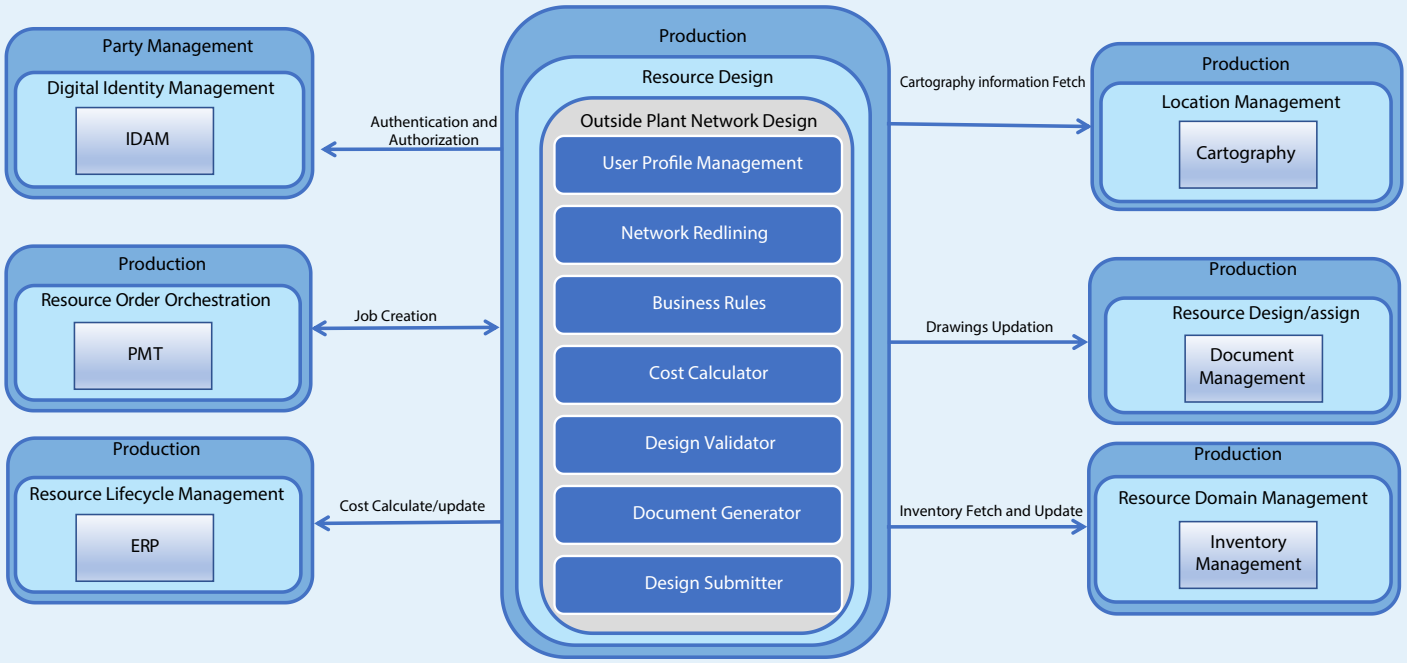
Below process can be followed to achieve the digitization of NEO

1. Listing down the e2e process tasks flow from NEO perspective post identification of opportunities.
2. Identification of manual and semi-automatic processes like HLD creation, as-is situation analysis, redlining, cost calculation, document generation, co-ordination meeting, high level design submission, design intake in detail design tool in the overall process flow.
3. Feasibility study and cost benefit analysis to identify and shortlist the processes that can be automated.
4. Solution blueprint of all the shortlisted processes is done
5. Solution is executed to achieve the NEO process automation

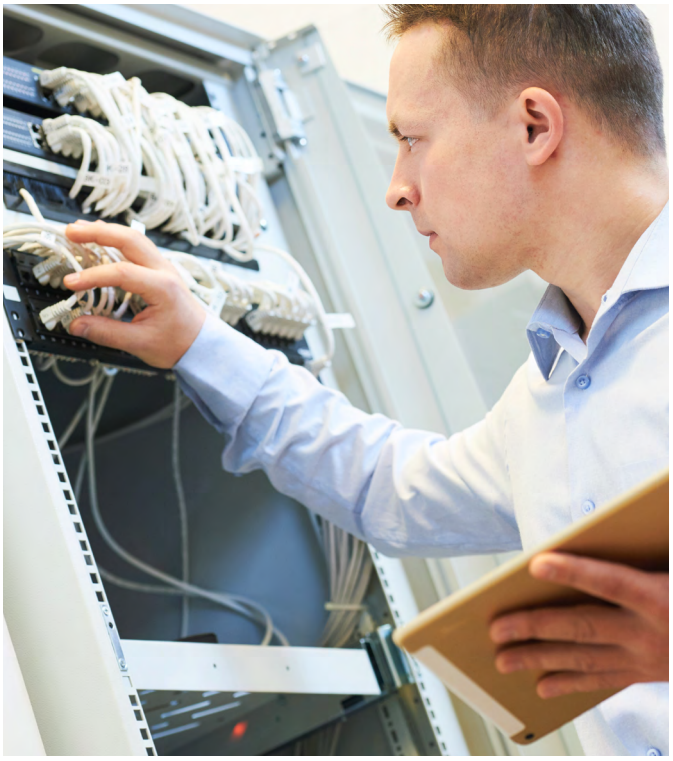
8. NEO from Ideation to Realization

This section describes open-source based reference implementation of NEO as identified in section 7.

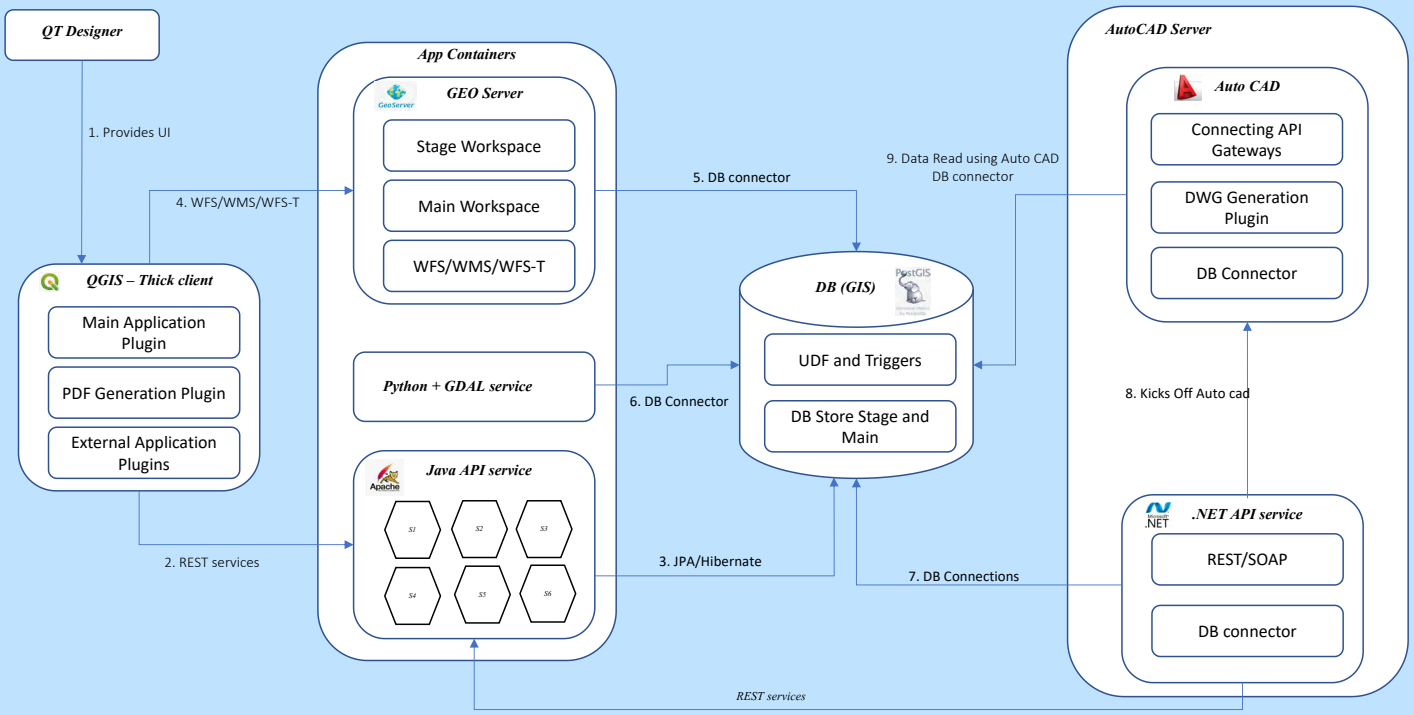
8.1 Functional Building Blocks of Solution



- The solution is described with reference to TMF – ODA (Production Block)
- Main functional components of implemented solution include the following:
  - **Automatic** synchronization of **GIS** Inventory in multiple systems
  - **Real time validation** of design based on **configurable** business **rules**
  - **Real** time **cost calculation** as application is integrated with **enterprise grade cost calculation system**
  - Enabling **automatic conversion**/migration from old technology **(Copper)** to new technology **(Fiber)**
  - **Realization** of earnings based on **De-documentation** of old technology **(Copper)**
  - **Real time document generation** for internal and external **meetings**
  - Update the **modifications in the GIS** inventory of **multiple systems**



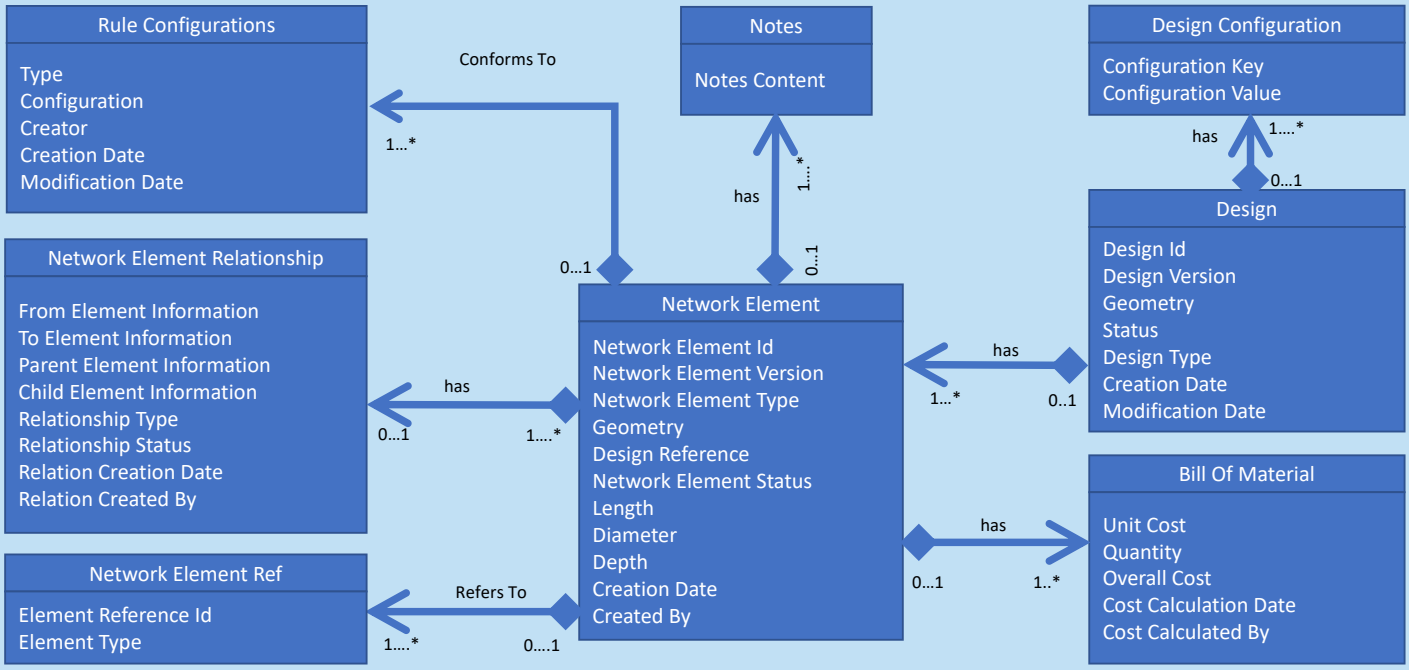
8.2 Technical Building Blocks of Solution



- Solution leverages **opensource** technologies and basic principle of **loosely coupled architecture** in order to bring automation in traditional manual processes: -
- Usage of opensource **QGIS** as user interface for the application in order to perform designing
  - Usage of opensource **Post GIS** database. It is basically a **wrapper** on top of **Postgres** Database for storing **OGC** complaint **GIS** data
  - Usage of opensource **Geo server** for rendering layer on UI
  - Usage of **standard API's** developed in **java/j2ee** for enabling different business functions
  - Usage of **GDAL** based API developed in **python** for processing the **GPKG**
  - Robot based use of **Auto CAD** micro app developed in **.NET** for generating the **PDF** and **DWG** documents
  - **Open shift** based deployment platform for **one touch** deployment of backend **microservices**

Varied Technologies could be explored for implementing the layered implementation for Network Design Engine aligned with cloud Native Microservices Architecture as mentioned in section 8.5

8.3 Conceptual Data Model



Explanation of conceptual data model: -

1. Designs are created based on different design and system / technology configurations
2. Each design makes use of network element which further reference to type of element and the details. Network element specific information is stored in notes as well
3. Different elements are related with each other based on inside, on, connected, containing type relationships.
4. CRUD and relationship on the network element is defined by configurable business rules
5. Bill of material is used to arrive at total cost associated with given network design. Where the cost of design is calculated based on CRUD performed on different network elements.

8.4 Salient Features

Below are the salient feature of solution:-

- Loosely coupled Polyglot Microservices based architecture
- Usage of Open Source Technologies
- OGC complaint solution
- Network Technology (Copper or Fiber) agnostic RAAS implementation for dynamic rules
- Reducing the use of Licensed software and number of licenses by using Robots
- Flexible Symbology
- Automatic Data sync with Detail Design systems
- Automatic Cost Calculations
- One Click Deployment of application using Open Shift Containers

8.5 Technology Landscape

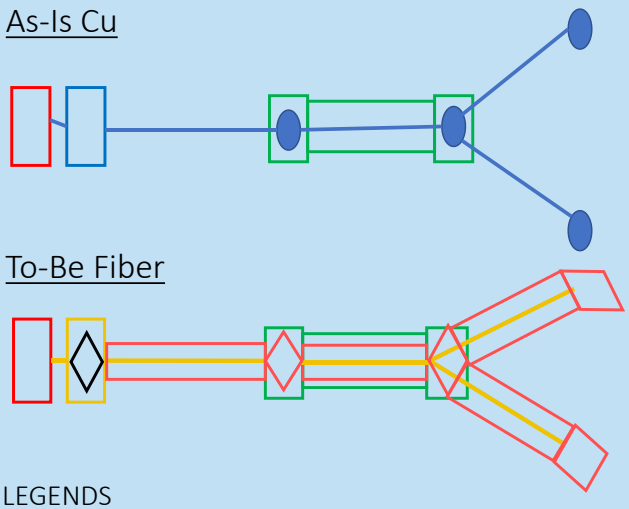
This section provide information about Technology Landscape using which the NEO solution can be implemented.

Front End	Middle Ware	Data Base	Infra

9. NEO: Fiber Rollout and Copper De documentation

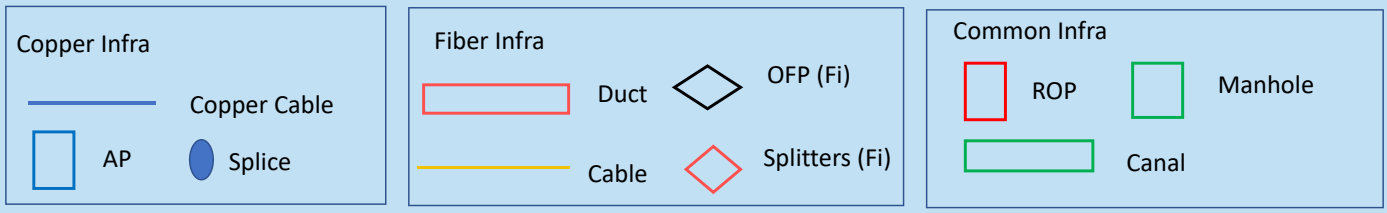
Below diagram list down to different steps involved in design phase in order to rollout Fiber and de document existing Copper infrastructure: -

In the below diagram transformation from Copper Network to Fiber Network is depicted: -



- There are some inventories common between multiple Technologies. E.g. For ground based deployment, Manholes, Pipes and Canals are common inventory. These will remains as it is
- Some inventories becomes outdated due to New Technologies Rollout. Depending on cost, these are taken out and sold. (some time it is not feasible due to cost implications)
- New Inventories are installed which are required for new technologies.

LEGENDS



Given below is detailed explanation of copper de-documentation along with fiber rollout:-

1. Design area is defined in order to initiate the migration of copper network to fiber network. Primary LEX and its associated connections are identified in the design area.
2. Complete Inventory of network element is retrieved based on design area.
3. If there are multiple primary LEX then separate de-documentation process is initiated for each.
4. Possibility of copper cable retrieval from ground is determined. Based on it, spare capacity of canal is determined for placement of further fiber cables and ducts inside it.
5. Fiber cable and fiber ducts can be placed as below: -

   a. There is no opportunity to free up capacity in canal by removing existing copper cables or post removal canal capacity is not sufficient.

   b. Where there is no canal available and cable needs to be placed underground

   c. Where there is no canal available and cable needs to be placed on façade

   d. Canal has sufficient capacity to place fiber cables and fiber ducts

   For first two use cases, trenching requirements are determined for placing fiber cables inside fiber ducts. For rest of use cases no trenching is needed.
6. Overall requirement of fiber cable, fiber duct and other infra is determined.
7. Infra requirements are validated based on pre-defined rules.
8. Auto correction algo resolve any data quality or validation issues. Any pending issue is flagged for manual correction.
9. Post correction of infra requirement, the total cost of bill of material is determined, it takes into account profit received from retrieving the copper cables from ground.
10. Post getting go-ahead the design is submitted for further processing
11. PDF/DWG or any other format based submitted design document is auto-generated which can be shared by designers in the co-ordination meetings

Point to note: Some time new technology rollout can use the existing infrastructure. In those cases, rather than decommissioning, the infrastructure can be reused for new technology.

10. Salient Features

Salient Feature of the solution are given below. Solution is:-

- Based on **loosely coupled and polyglot** Microservices architecture
- Using **Open Source** Technologies
- **OGC** complaint
- **Cloud Native**
- Implemented using **technology** (Copper or Fiber) agnostic **RAAS** implementation
- **Reducing** the use of **licensed** software and number of licenses by using **Robots**
- Using dynamic and **configurable** rules for **topology, containment** and **status**-based Network Management
- Enabling **Automatic Data** sync with **Detail Design** systems
- Enabling Automatic **Cost Calculations**
- Enabling One **Click Deployment** of application using **Open Shift** Containers

11. Architectural Excellence

- Microservice based Loosely couple architecture is defined in start which is deployed on Open shift. However during implementation of solution, lot of architectural challenges were faced which required the novel solutions since GIS is niche domain.
- Following table lists the issues identified and approach taken for resolution

Sr. No.	Issue	Description	Resolution
1	DWG implementation issue	DWG support is not available in QGIS.	DWG is generated using Auto Cad and .NET API as batch process
2	GPKG ingestion issue	GDAL (Geospatial Data Abstraction Library) package used to process GPKG not advisable in java technology	A new microservice in python with GDAL is used to process GPKG
3	PDF functionality issue	PDF generation using QGIS library results into performance issue and results into blocking user from performing further work.	PDF is generated using Auto Cad and .NET API as batch process
4	Configurable business rules for redlining validation	Redlining rules for validation were not flexible.	RAAS (rule as a service) implementation using java ensures that same rules can be used for all network elements with basic configuration and no code change
5	Automatic conversion of technology	There are common elements for copper as well as fiber network. There is need to replace copper with fiber. Upgrading the whole infrastructure is challenging and time consuming.	Configurable business rules API to enable automatic conversion from copper to fiber for a given area is implemented
6	Automatic Issue resolution	There is need to automatically harmonize as-is infrastructure with current design infrastructure periodically.	A separate microservice in java is implemented to achieve automatic harmonization

12. Solution Benefits

- No more manual process to keep on updating the design using Drafter due to change in As-Is Infrastructure/business requirement and/or Co-ordination meeting/Govt Agencies decisions etc.
- It provides cost effective solution with Faster TTM for maintenance and de-documentation of old technologies (Copper) and rollout of new technologies (Fiber) by implementing below:-
  - Automatic Syncing with As-Is Infra
  - Automatic Designing as per As-Is Infra
  - Automatic Cost Calculation
  - Automatic Document/Print Generation
- Faster time to market, with automation the HLD takes almost 50% less effort which translates to 2 Person Days of reduced effort per design. So if we consider 150 designs created in a calendar year, then it translates to 300 Person Days of effort reduction in a year
- Total Cost of ownership (TCO) is less as no major license cost involved and solution is developed in-house
- Complete control of Product and Data
- Better Retention of customers as they will get differentiated services ahead of competitors
- Opportunity to gain new customers

13. Relevance for Other Industries

- NEO Optimization is primarily intended for **Telcos**
- But it can be suitably extended to other industries based on business challenges mostly related to **GIS domain**. For Example:-
  - **Energy companies** can replace their **Old in-efficient** wiring system to more efficient **New Age Digital Wiring** system
  - **Banks** can use the similar implementation to replace the existing **Old** generation **ATM's** to **New** Generation **ATM's**
  - **EV Charging** enablement for **Telcos, Energy Distribution** and **Generation** companies can be achieved using the similar solution
  - **Automatic** designing of **Mechanical Tool** (like **Big Boilers** etc.), can be achieved with suitable automatic solutions

Author
Mukesh Gupta
Senior Technology Architect

Mentor
Nishi Mathur
AVP-Senior Principal
Technology Architect

Mentor
Gnanapriya C
AVP-Unit Technology Officer