Prodapt Chase Extraordinary

Use AI to Bolster your Network Capacity Planning decisions

Credits

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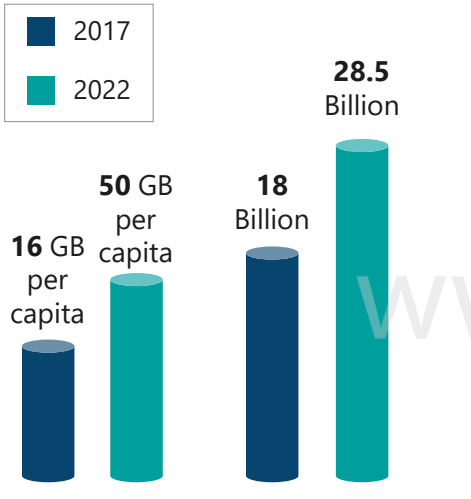
CDN capacity planning getting more critical with rise in global IP traffic

Video will account for 82% of entire traffic by 2022

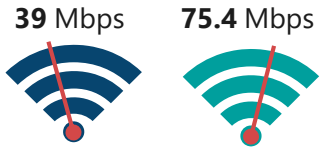
Global IP traffic is expected to increase threefold



Increase in monthly global IP traffic.

More devices & connections

Faster broadband speeds



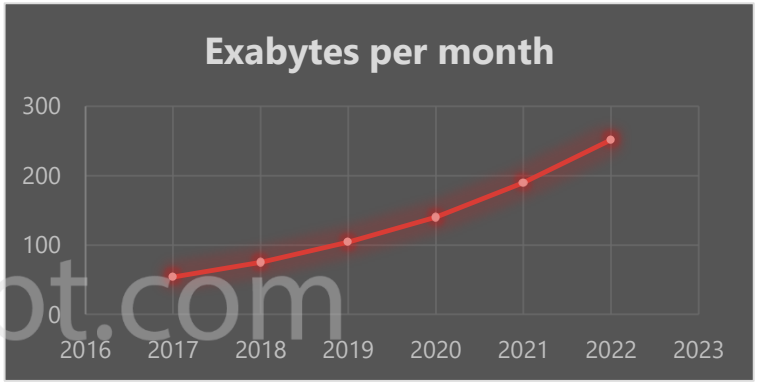
More Video viewing

75% of all IP traffic

82% of all IP traffic

Source: Cisco VNI: Forecast and Trends, 2017–2022

Data volume of global Content Delivery Network(CDN) traffic is increasing exponentially



In 2022, worldwide online CDN traffic is projected to reach 252 EB per month, up from 54 EB per month in 2017.

Source: Statista 2019

Exponential increase in CDN traffic is putting a lot of pressure on DSPs to find new methodologies for optimizing exiting capacity and accurately predicting future capacity requirements.

In today's competitive landscape, satisfying the customer's demand in a timely fashion is very crucial for DSPs.
In order to achieve this goal, it is necessary to have a well designed planning system as well as a sound capacity expansion strategy.

Challenges faced by DSPs in capacity planning decision with big bandwidth growth!

Traditionally, capacity planning was mostly a manual process that used basic statistical tools to collect data and set an alert on a static threshold. However, with the big bandwidth growth these traditional approaches are doomed to fail.

Complexities have grown exponentially and traditional approaches are ineffective!

Network traffic is becoming **extremely dynamic** due to increased mobility and heterogeneous demands of users.

With constant growth in media consumption, operators are experiencing significant fluctuations in capacity demands based on **seasonal changes.**

External influencing factors such as sports events, political campaigns or a sensational video can cause a sudden increase in network traffic causing the network planning to go haywire.

Internal influencing factors such as new product launches, new offers or sales promotions can also cause a significant fluctuations in capacity requirements.

Using traditional approach in current landscape can lead to incorrect forecast conclusions. With this, DSPs often run out of capacity due to the pressure of increasing data consumption and changes in consumption patterns that are not identified during capacity planning.

Need to balance two conflicting demands for DSPs

Maximize user experience

To enhance the customer experience, DSPs need to satisfy the growing demand at scale **by building large scale physical network capacity**.
Also, to avoid bottleneck on a central server, DSPs need to **put the contents to servers on the edge**, thereby minimizing the delays between content orders and actual downloads.

Reduce operational cost

However, to provide this high quality user experience, DSPs need to rollout new networks, which is **capital intensive**. The challenge here is to determine exactly where and how much to invest to increase their ROI.

Network planners need to confront these challenges before it impacts the customer experience. This insight talks about how DSPs can build robust capacity modeling tool to manage current capacity more effectively & predict future capacity requirements more accurately.

Building a robust capacity modeling tool to forecast capacity

A capacity modeling tool collects data from different sources to accurately predict when demand for a given resource may outweigh the capacity to deliver it. The model makes it possible to determine which infrastructure upgrades will deliver a return in increased customer business and reduced churn.

Read data from all sources

- **Existing CDN components usage**
- **Customer Premises Equipment**
- **End user devices**
- **Internal factors**: (Product launces, sales promotions etc.)
- **External Factors**: (Sports, events, campaigns & elections etc.)

Data Inputs → Central Data Hub

Forecast evolution of the demand for each service

python, kibana, elasticsearch

Central Data Hub → Data Processing Tools → Processed Data → Capacity Modeling Tool

Built with efficient pattern recognition and self-learning (ML) model

Compute for each component the number of units required to handle the load

Capacity Modeling Tool → Alert Conditions (High, Medium, Low) → Operations Team

Capacity Modeling Tool → Prediction Report → Capacity Planning Team

- **Throughput**
- **CPU, memory**
- **Storage**
- **License**

Capacity Modeling Tool

Back-end
- Data extraction & manipulation
- Exploration of data
- Forecasting

→

Front-end (Grafana)
- Dashboard generation
- Impact assessment
- Capacity report generation

→ **Automated dashboard with analytics capabilities**

Factors to consider while selecting à forecasting model

- Context of the forecast
- Relevance and availability of historical data
- Desired degree of accuracy
- Time period to be forecasted
- Cost/benefit (or value) of forecast to the company
- Time available for making analysis

The CDN data traffic has huge number of datasets and choosing one model which performs best with all the datasets is not that straightforward. The subsequent slides help to narrow down the right set of forecasting model that will provide better forecasting for capacity planning.

Classical time series forecasting methods for capacity planning

Classical forecasting models

Without trend and seasonal components

- Autoregression (AR)
- Moving Average (MA)
- Autoregressive Moving Average (ARMA)
- Simple Exponential Smoothing (SES)

With trend and without seasonal components

- Autoregressive Integrated Moving Average (ARIMA)

With trend and/or seasonal components

- Seasonal Autoregressive Integrated Moving Average (SARIMA)
- Seasonal Autoregressive Integrated Moving Average with Exogenous Regressors (SARIMAX)
- Holt Winter's Exponential Smoothing (HWES)

Capacity planning is univariate time series forecasting problem and thus requires models suitable for univariate time series data. Given are the classical forecasting models that can be used based on the trend and seasonality of univariate dataset

Evaluating the classical approach

Classical forecasting methods must be carefully evaluated and compared with modern ML models as it is observed that some simple classical methods might outperform complex modern ML methods. However, when it comes to predicting network capacity in a CDN network, it is observed that the classical approach does not give acceptable result. This is mainly because of following reasons.

Dynamic nature of video watching pattern

Mostly a decade back, TV was a major source for users to consume the video traffic. For this, the statistical formulas worked fairly well to predict the future capacity. However, in present context the video watching pattern has changed completely. Users now have flexibility to watch videos across various digital devices on the go across different network and bandwidth. The classical approach mostly fails to incorporate this dynamically changing trend of current traffic usage.

White noise and random walk present in the observed dataset is not reflected in the forecast

The classical models do not consider modeling the noise components that comes along with the raw dataset & can thus influence the forecast.

Using only the classical time series forecasting methods may not yield an accurate capacity forecast, which is critical for operators in an effective CDN capacity planning.

Modern machine learning methods for capacity planning

Machine learning Methods

- Gaussian Processes (GP)
- Least absolute shrinkage and selection operator (LASSO)
- Gradient Boost Regressor (GBR)
- Ensemble Method

Neural network and Deep Learning

- Auto Regressive Neural networks (NNAR)
- Long Short-Term Memory (LSTM)
- Neural Network Time Series Forecasting (NNETAR)
- DeepAR - AWS

To handle increasing variety and complexity of predictive modeling problems, many modern machine learning methods have been developed in the recent years. Given are some modern machine learning and deep learning methods that can be used for capacity planning.

The modern machine learning method **can be a costly affair and yet may or may not be effective**. Thus, a customized approach using hybrid ML methods is required to make the capacity prediction more robust and inclined to business needs.

Evaluating modern machine learning approach

Machine learning and deep learning methods are often considered as key solution to complex predictive problems. However, when it comes to predicting the future capacity, one must carefully evaluate if the added complexity with modern ML methods is adding true value in improving the overall forecast quality.

Complex ML methods come with following drawbacks:

Financially and computationally costlier

Deep networks require high-end expensive GPUs to be trained for a reasonable amount of time with big data. Without this, high performance would be hard to achieve. Thus it needs to be carefully thought, if cost of further gold plating is justified to achieve a better accuracy.

Predicting single point capacity is not what business demands

Complex ML models can give near accurate forecast for single point capacity, but this is not what the business demands. In capacity management, it is not that crucial to predict immediate next day traffic. Rather it requires to understand the overall traffic growth for at least 3-6 months ahead for which a proper planning can be done in advance.

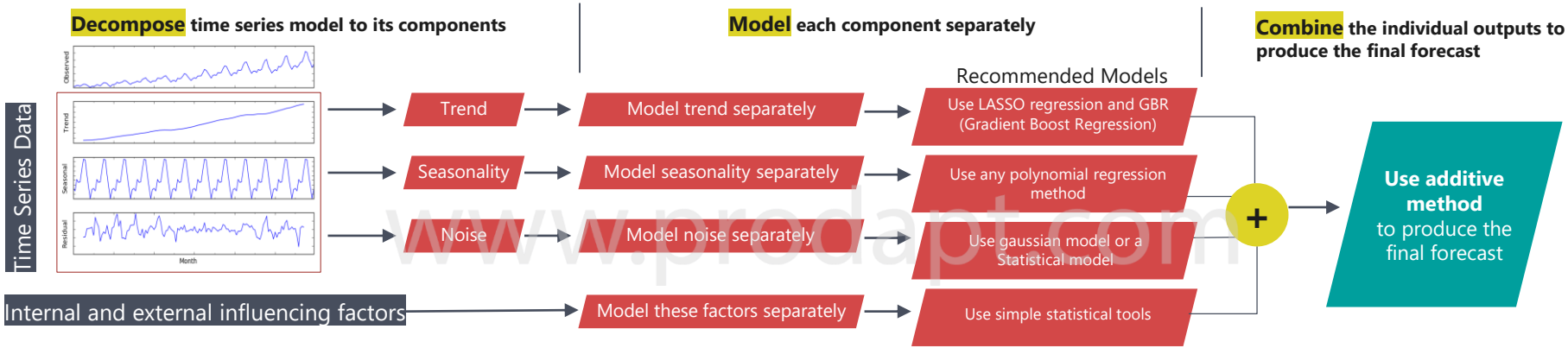
Difficult to incorporate input datasets for external and internal influencing factors

Predicting future demand only using past data doesn't work anymore. This requires to feed the datasets of external and internal influencing factors into the model. However, the complex modern ML models doesn't give the flexibility to do so.

Building a customized hybrid machine learning model

A customized hybrid model shows how combination of different classical and ML models can help in improving overall prediction, thereby overcoming the limitations with classical and modern ML methods.

A customized hybrid machine learning method can be a 3-step process: Decompose, Model and Combine



Modeling trend component to produce convincing results

- ML model produces results whatever it learns, which can be both positive and negative. However, analyzing the global IP traffic, it is very clear that future capacity trend would either be positive or neutral. Thus it is advisable to use model that can filter the negative forecasting. One such model is **Lasso regression** (least absolute shrinkage and selection operator)
- Next, combine the time features and o/p from Lasso regression and feed into **gradient boosting regression** which gives better result than going for a single model

Improvising the model by incorporating internal and external influencing factors

Apart form the time series (history) data there are several internal and external factors that can influence the capacity requirement. Thus, it is also very much important to take these into account. Using a hybrid ML model gives the flexibility to incorporate other influential factors into the model.
Internal factors: Business inputs, product inputs, sales promotions etc.
External factors: Sports events, election & campaigns etc.

Case study: CDN capacity planning for a leading digital service provider (DSP) in Europe

Business Challenge

One of the leading DSP in Europe faced a critical problem of running out of CDN capacity due to the pressure of increasing data consumption and changes in consumption patterns that are not identified during capacity planning

Benefits

Following are the benefits of robust hybrid ML model deployment for CDN capacity planning

- **Zero** capacity failures observed in past one year for the DSP having it's presence in **15+** countries with more than **25M** customer base.
- New areas of **capacity risks in different parts** of network were **identified much in advance**. Helped DSP to timely accommodate and plan for the required future capacity and also do impact assessments and invoice generation for new components.

Solution

Implementation of a **customized hybrid machine learning model** for CDN capacity planning built with efficient pattern recognition and self-learning capability. It also provided an automated interactive dashboard to visualize and act on the data being presented.

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THANK YOU!