Split – Load System

Submitted by

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Submitted for the partial fulfillment for the degree of Bachelor of Technology in Computer Science and Engineering

Techno Main Salt Lake
EM 4/1, Salt Lake, Sector – V, Kolkata – 700 091.

CERTIFICATE

This is to certify that the project "Split-Load System" prepared by Alka Prasad (13000116138), Mohit Kumar (13000116094), Avnish Kumar (13000116121), Abhishek Das (13000216135) of B.Tech (Computer Science & Engineering), Final Year, has been done according to the regulations of the Degree of Bachelor of Technology in Computer Science & Engineering. The candidates have fulfilled the requirements for the submission of the project report.

It is to be understood that, the undersigned does not necessarily endorse any statement made, opinion expressed or conclusion drawn thereof, but approves the report only for the purpose for which it has been submitted.

Mr. Srimanta Kundu	Mrs. Poulami Dutta
(Signature of the Internal Guide)	(Signature of the HOD)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our mentor of the department of Computer Science and Engineering, whose role as project guide was invaluable for the project. We are extremely thankful for the keen interest he / she took in advising us, for the books and reference materials provided for the moral support extended to us.

Last but not the least we convey our gratitude to all the teachers for providing us the technical skill that will always remain as our asset and to all non-teaching staffs for the gracious hospitality they offered us.

Place: Techno Main, Salt Lake

Date: 15/06/2019

Abhishek Das

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Alka Prasad

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Anish Kumar

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Mohit Kumar

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Contents

1 Introduction

1.1 Abstract

Our model Split-Load System revolves around the domain of Computer Networks and works on enhancing the download speed.
The report demonstrates the existent file downloading techniques along with their pros and cons.

Their inefficiencies and requirement of human intervention motivated us to undertake this project. We have incorporated the concepts of 2 highly successful and well-known services- Internet Download Manager and Torrent. While IDM works on a single computer, we have extended parallel segment downloading on multiple computers. Our proposed solution:

File is downloaded in segments on each Computer. These segments are shared among all of them which are then merged to get a complete file on each computer. The respective client nodes download the chunks of file and subsequently the merging process takes place which lets the complete file get downloaded in each client. The process of uploading segments while downloading has been borrowed from Torrent[7].

These features make our product efficient, robust and obviously, fast. The report also explains the assumptions taken and the various advantages provided by the product.

1.2 Problem Domain

All the computers on the LAN that require the same file send a request to the server independently. All of them share the same bandwidth. As all clients work independently, even if one node goes down, none of the nodes are affected. There is no need of any communication among the Computers on the LAN. Huge traffic gets generated due to so many downloads and many times thereby creating redundancy. This also leads to a lot of data wastage.

Our solution provides much better result than the existing method. One computer on the LAN downloads the file from the server and then shares it on the local network, so that all the systems that require that file can download it locally. Since transfer of file on LAN is generally faster than that from the ISP, it proves to be quite efficient. As data is downloaded once from the server, it uses less data and hence consumes less time[3].

1.3 Related Studies

- **Naive Solution:** All the clients work independently, and the file is downloaded separately on each computer. Due to this huge traffic takes. Huge amount of data is wasted, and a lot of manual effort takes place.

- **Better Approach**: One system downloads the file from the server. After the download, the system shares the file to all other systems via LAN.

- **IDM:** Most of the servers allow more than one connection to a SINGLE FILE STREAM from any client IP address requesting the file. IDM first checks whether multiple connections to the file can be made or not. Now that IDM knows that the server allows multiple connections, it makes requests to the server for the file that it wants to download, and the server returns a "BYTE STREAM". Now, we can specify from which byte, the byte stream to be returned from the server should start. IDM also supports `Dynamic Segmentation` [1] i.e., the total file-byte-segments being downloaded may increase over the download process. It basically breaks an existing file-byte-segment into two for even more network utilization. Although the concurrent active network calls are fixed (what you set inside the application), but the calls can be divided over the file-byte-segments being downloaded [10].

- **Bit Torrent: Torrent[4],** peer to peer file sharing, works like this. First you have the trackers. When you add a torrent, your torrent client checks through the list of trackers it has, and contacts all the trackers part of the torrent to say "hey, I'm here!". Trackers also point you in the direction of other anonymous torrent seeders with the same torrent. Seeders are people who keep uploading a torrent to strengthen the network. When you download a torrent, you download it from the random seeders. It's ensured that each part is intact via the torrent's metadata via a checksum, it will ensure that the contents haven't been tampered by any of the peers [2].

1.4 Glossary

- [Multicast] - Group communication where data transmission is addressed to a group of destination computers simultaneously. Multicast[11] can be one-to-many or many-to- many distribution.

- [LAN]: A Local area network (LAN) is a computer network that spans a relatively small area. Most often, a LAN is confined to a single room, building or group of buildings, however, one LAN can be connected to other LANs over any distance via telephone lines and radio waves.

- [Bandwidth]: Bandwidth is the capacity of a wired or wireless network communications link to transmit the maximum amount of data from one point to another over a computer network or internet connection in a given amount of time- usually one second.

- [Broadcast]- Broadcasting is the simultaneous transmission of the same message to multiple recipients. In networking, broadcasting[12] occurs when a transmitted data packet is received by all network devices.

- [Client]: A client is a piece of computer hardware or software that accesses a service made available by a server. The server is often (but not always) on another computer system, in which case the client accesses the service by way of a network.

- [Server]: a computer or computer program which manages access to a centralized resource or service in a network.

- [HTTP]: The Hypertext Transfer Protocol (HTTP) [13] is an application protocol for distributed, collaborative, hypermedia information systems. HTTP is the foundation of data communication for the World Wide Web, where hypertext documents include hyperlinks to other resources that the user can easily access, for example by a mouse click or by tapping the screen in a web browser.

- [TCP]: TCP stands for Transmission Control Protocol[14]. It is a fundamental protocol within the Internet protocol suite — a collection of standards that allow systems to communicate over the Internet. It is categorized as a "transport layer" protocol since it creates and maintains connections between hosts.

- [UDP]: User Datagram Protocol (UDP) [15] is part of the Internet Protocol suite used by programs running on different computers on a network. UDP is used to send short messages called datagrams but overall, it is an unreliable, connectionless protocol.

- [IP]: IP stands for Internet Protocol. It provides a standard set of rules for sending and receiving data over the Internet.

2 Problem Definition

2.1 Scope

The project relies on TCP as well as the concepts of torrent to get the job done. Downloads can be segmented because HTTP protocol [8] allows the client to specify the start position of the stream.

- Improvement in the speed of downloading a file from a server and distributing it to the other Computers on the Local Area Network. Currently, two models for downloading exist:
  - Download the same file from the server simultaneously on all the computers.
  - Download the file in a single computer and host it on the local network to be downloaded by the connected Computers. This method generally performs much better than the first one as the Bandwidth of a LAN is more than that of a connection from the ISP Download the file in a single Computer and host it on the local network

- to be downloaded by the connected Computers. This method generally performs much better than the first one as the Bandwidth of a LAN is more than that of a connection from the ISP.

2.2 Exclusions

While creating our project, to increase the efficiency and to decrease the complexity, we have made certain exclusion. We have not yet incorporated an algorithm to distribute the load if a node or a series of nodes crashes. Also, our project excludes the algorithm to support simultaneous multiple file downloads.

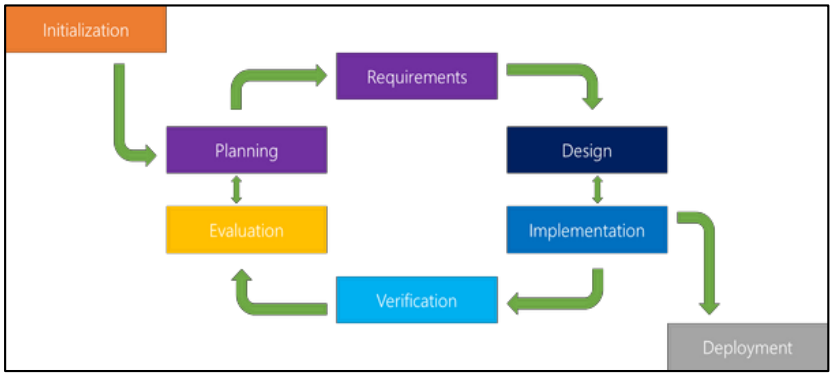
2.3 Assumptions

- There should be multiple connections for a single IP.
- There should not be any bandwidth limit per connection.
- As the sharing will be done over a LAN connection, therefore the bandwidth for the LAN must be much greater than the bandwidth of the ISP.
- There should be a stable internet connection for smooth functioning.

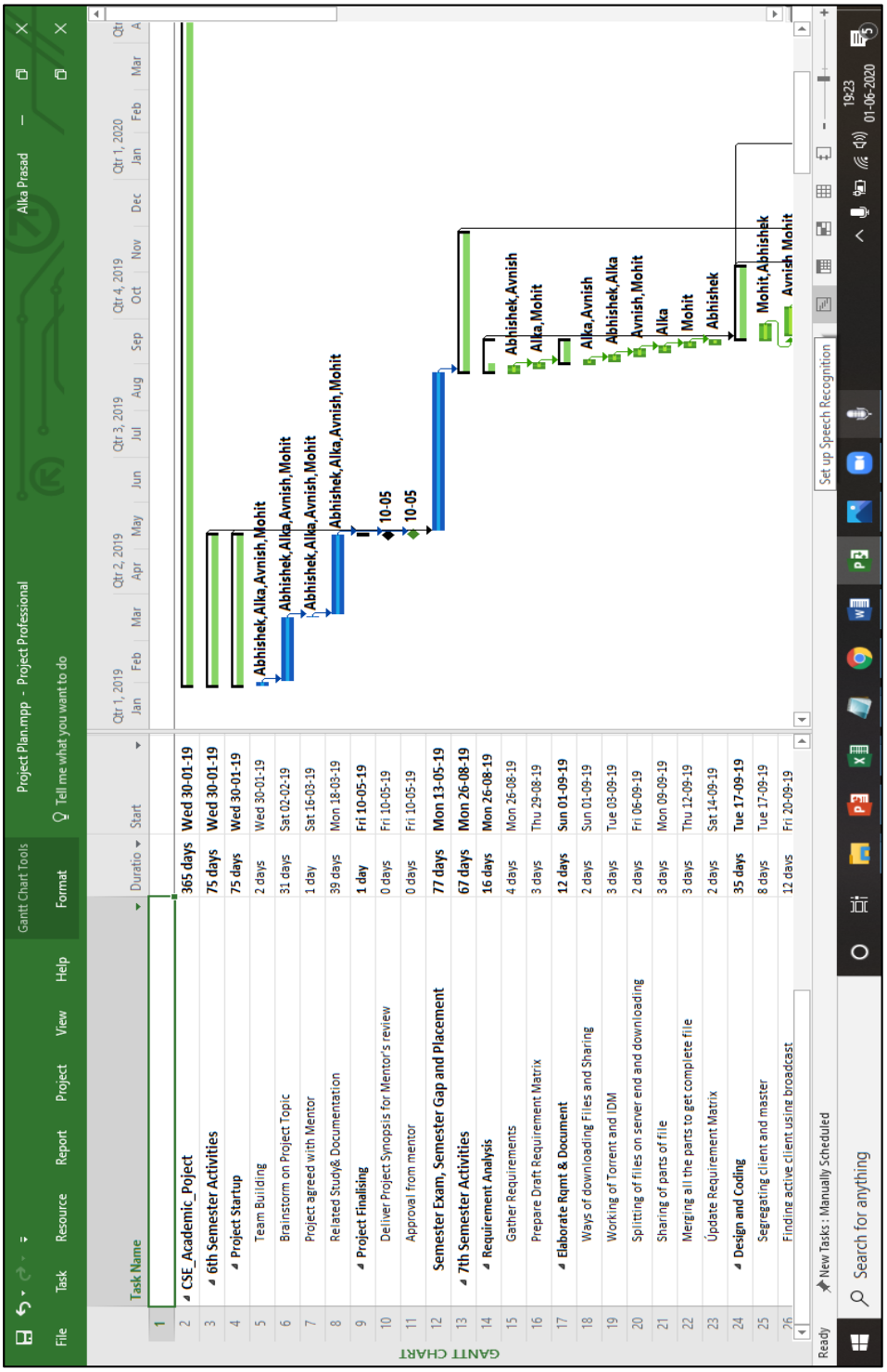
3 Project Planning

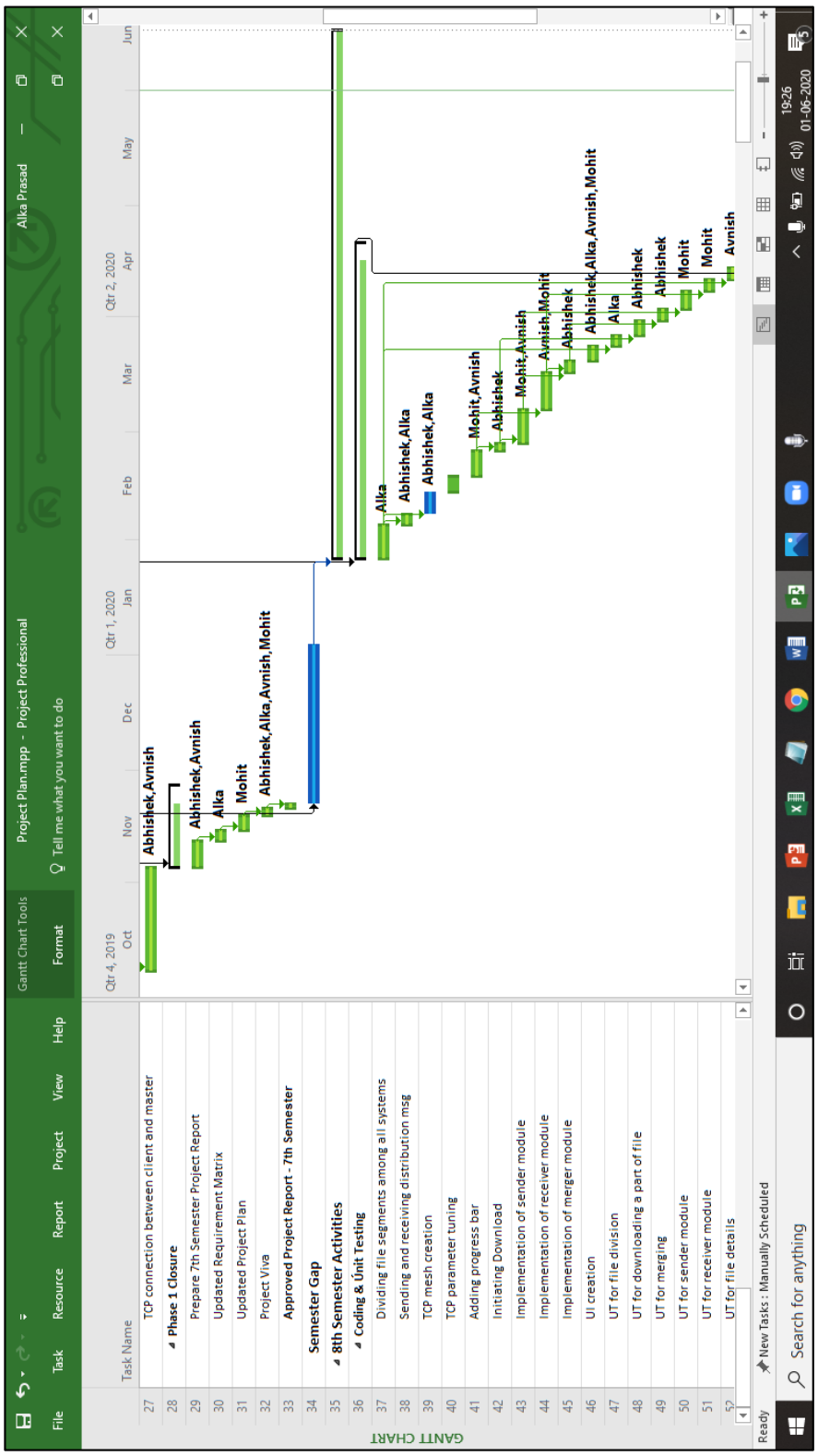
3.1 Software Life Cycle Model

The classical waterfall model[16] is intuitively the most obvious way to develop software. However, it is not a practical model. This model considers the transition between two phases to be similar to a waterfall. That is, once a phase is complete, the various activities during the phase are assumed to be flawlessly done and there is no scope for rework later. In this project, we have used a modified version of the waterfall model, which is called the iterative waterfall model of development. In this model, there is a feedback path from every phase to its preceding phase. The feedback paths allow for correction of the errors committed during a phase, as and when these are detected in a later phase.



3.2 Scheduling

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Tell me what you want to do
Alka Prasad
File
Task
Resource
Report
Project
View
Help
Task Name
TCP connection between client and master
Phase 1 Closure
Prepare 7th Semester Project Report
Updated Requirement Matrix
Updated Project Plan
Project Viva
Approved Project Report - 7th Semester
Semester Gap
8th Semester Activities
Coding & Unit Testing
Dividing file segments among all systems
Sending and receiving distribution msg
TCP mesh creation
TCP parameter tuning
Adding progress bar
Initiating Download
Implementation of sender module
Implementation of receiver module
Implementation of merger module
UI creation
UT for file division
UT for downloading a part of file
UT for merging
UT for sender module
UT for receiver module
UT for file details
Abhishek,Avnish
Abhishek,Avnish
Alka
Mohit
Abhishek,Alka,Avnish,Mohit
Alka
Abhishek,Alka
Abhishek,Alka
Mohit,Avnish
Abhishek
Mohit,Avnish
Avnish,Mohit
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Avnish
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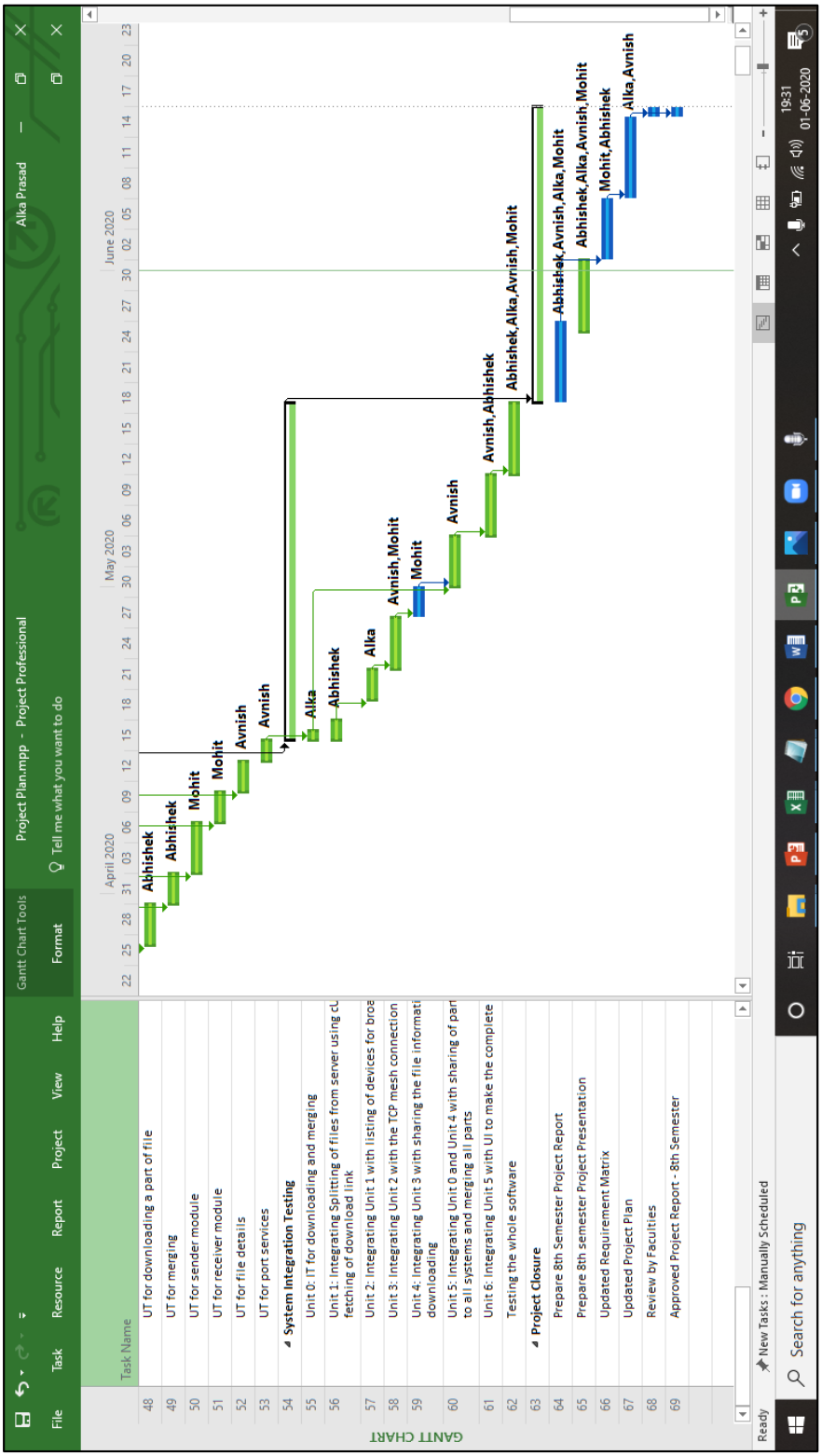
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Tell me what you want to do
File
Task
Resource
Report
Project
View
Help
GANTT CHART
Task Name
UT for downloading a part of file
UT for merging
UT for sender module
UT for receiver module
UT for file details
UT for port services
System Integration Testing
Unit 0: IT for downloading and merging
Unit 1: Integrating Splitting of files from server using cl
fetching of download link
Unit 2: Integrating Unit 1 with listing of devices for broa
Unit 3: Integrating Unit 2 with the TCP mesh connection
Unit 4: Integrating Unit 3 with sharing the file informati
downloading
Unit 5: Integrating Unit 0 and Unit 4 with sharing of part
to all systems and merging all parts
Unit 6: Integrating Unit 5 with UI to make the complete
Testing the whole software
Project Closure
Prepare 8th Semester Project Report
Prepare 8th semester Project Presentation
Updated Requirement Matrix
Updated Project Plan
Review by Faculties
Approved Project Report - 8th Semester
April 2020
May 2020
June 2020
Abhishek
Abhishek
Mohit
Mohit
Avnish
Avnish
Alka
Abhishek
Alka
Avnish,Mohit
Mohit
Avnish
Avnish,Abhishek
Abhishek,Alka,Avnish,Mohit
Abhishek,Avnish,Alka,Mohit
Abhishek,Alka,Avnish,Mohit
Mohit,Abhishek
Alka,Avnish
Ready
New Tasks : Manually Scheduled
Search for anything
19:31
01-06-2020

3.3 Cost Analysis

The basic COCOMO[5] model gives an approximate estimate of the project parameters. The project we are working on is an organic model.

Organic: A development project can be considered of organic type, if the project deals with developing a well understood application program, the size of the development team is reasonably small, and the team members are experienced in developing similar types of projects.

Software Product	A	B	C	D
Organic	2.4	1.05	2.5	0.38

COST ESTIMATION

Estimation Formula:

$\text{Effort} = 2.4*(\text{KLOC})^{1.05}$ PM

$T_{dev} = 2.5*(\text{Effort})^{0.38}$ Months

Where,

- KLOC= estimated size of the product expressed in Kilo Lines Of Code
- a,b,c,d are constants
- T_{dev} is the estimated time to develop the software, expressed in Months.
- Effort is the total effort required to develop the project estimated in Person Months.

Assume that the size of the organic type of software product has been estimated to be 1100 lines and the average salary of software engineers be Rs. 30,000/- pm. Determine the effort required and nominal development time of the project. (Use Basic COCOMO for this estimation).

$\text{Effort}=2.4*(1.1)^{1.05}==2.652$ PM.

$T_{dev}= 2.5*(2.652)^{0.38}= 3.62$ Months.

Cost required= 3.62*30,000= Rs 1,08,656

4 Requirement Analysis

4.1 Requirement Matrix

Rqmt ID	Requirement Item	Requirement Status	Design Module	Design Reference (section# under project Repo	Test Case Number	Technical Platform of Implementation	Prototype prepared ?	Name of Program / Component	Test Results Reference	Additional Comments (if not included in previous columns)
MSD-1.2	Master Initiates Download Procedure	Completed	MSD	6.2.2	T-MSD-1.2	Python	Yes	SplitLoad.py(function:startMasterUti())	Test Script: MSD-1.2	
BMS-1.3	Broadcast message sent	Completed	BMS	6.2.3	T-BMS-1.3	Python	Yes	function: listenBroadcast(arg), announceBroadcast(arg)	Test Script: BMS-1.3	
CTM-1.4	Client creates a TCP connection with Master	Completed	CTM	6.2.4	T-CTM-1.4	Python	Yes	function: listenTcp(arg), announceBroadcast(arg)	Test Script: CTM-1.4	
RCN-1.5	Range Calculation	Completed	RCN	6.2.5	T-RCN-1.5	Python	Yes	divideFile.py	Test Script: RCN-1.5	....
SDL-1.6	Sharing of download link	Completed	SDL	6.2.6	T-SDL-1.6	Python	Yes	function: sendDistributionMsg(args)	Test Script: SDL-1.6	
TCC-1.7	TCP Mesh Connection amongst the Client	Completed	TCC	6.2.7	T-TCC-1.7	Python	Yes	function: listenBroadcast(arg), listenClientTcpReq(arg)	Test Script: TCC-1.7	
TPT-1.8	TCP parameters tuning	In-progress	TPT	6.2.8		Python	No			Due to lack of multiple systems connected over ethernet in this COVID-19 situation
DFP-1.9	Downloading of the File parts	Completed	DFP	6.2.9	T-DFP-1.9	Python	Yes	SplitLoad.py, startDownload.py Function: initiateDownload(arg)	Test Script: DFP-1.9	...
SFP-1.10	Sharing of the File parts	Completed	SFP	6.2.10	T-SFP-1.10	Python	Yes	sendFile.py, recvFile.py	Test Script: SFP-1.10	....
MPF-1.11	Merging of all the parts of the file	Completed	MPF	6.2.11	T-MPF-1.11	Python	Yes	merge.py	Test Script: MPF-1.11	....
FPS-1.12	Free Port Service	Completed	FPS	6.2.12	T-FPS-1.12	Python	Yes	portServices.py	Test Script: FPS-1.12	

4.2 Requirement Elaboration

4.2.1 CUI-1.1:

Creation of a User Interface for the software.

4.2.2 MSD-1.2:

The machine that has been assigned as master starts the download.

4.2.3 BMS-1.3:

The broadcast message is sent to all the systems in the network.

4.2.4 CTM-1.4:

The supported systems create a TCP connection with Master

4.2.5 RCN-1.5:

Range of Bytes for division of the file is calculated.

4.2.6 SDL-1.6:

Sharing of download link with all other information to each client.

4.2.7 TCC-1.7:

All clients create a TCP connection amongst each other

4.2.8 TPT-1.8:

TCP connection is enhanced to improve the speed of download and share.

4.2.9 DFP-1.9:

Downloading of the file parts in all systems.

4.2.10 SFP-1.10:

Sharing of file parts while downloading.

4.2.11 MPF-1.11:

Merging of all parts of the file in all systems.

4.2.11 MPF-1.11:

Merging of all parts of the file in all systems.

4.2.12 FPS-1.12:

Get a Free TCP Port.

5 Design

5.1 Technical Environment

- **Hardware requirements:**

  ➢ **Minimum Hardware Requirements**

  • Windows 8
  • Processor: Pentium III
  • Hard disk drive 40 GB
  • RAM: 1 GB
  • Cache: 512 kb

  ➢ **Preferred Hardware Requirements**

  • Windows 10
  • Processor: Intel Core i3
  • Hard disk drive: 80 GB
  • RAM: 2 GB
  • Cache: 512 kb

- **Software requirements:**

  ➢ Our project is developed in Python 3.
  ➢ For developing the UI of our project, we have used pyQt5.
  ➢ cURL and copy command line tools are used in our software.
  ➢ In addition to this, we will include all our code in gitHub for better understanding and code sharing. Any Windows based operating system is primary requirements for software development.
  ➢ All system must be connected via LAN to internet, which is mandatory for the smooth execution of our software to download and share the file.

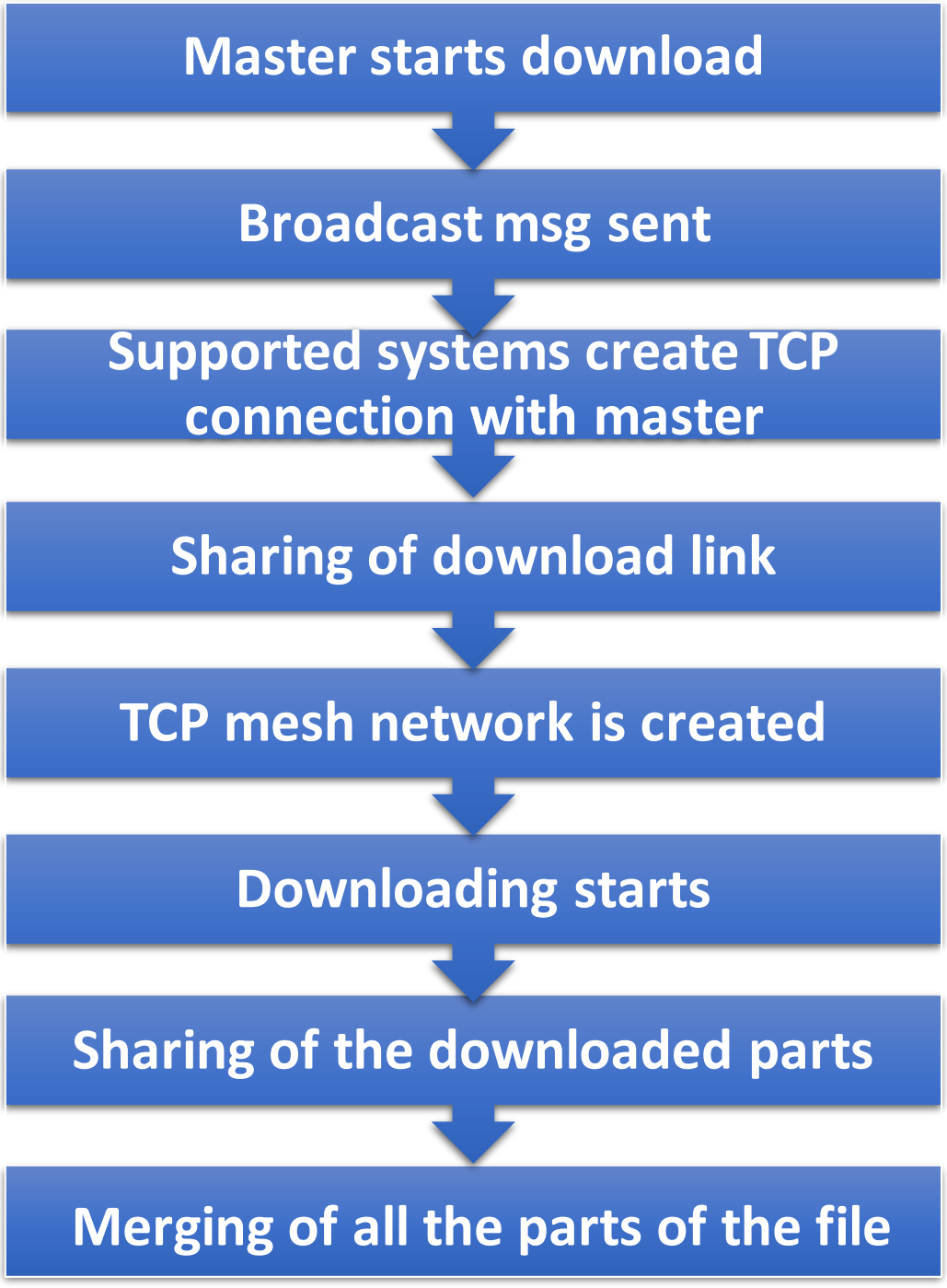
- **Other requirements:**

  Other requirements include-

  - Security
  - Portability
  - Correctness
  - Efficiency
  - Flexibility
  - Testability
  - Reusability

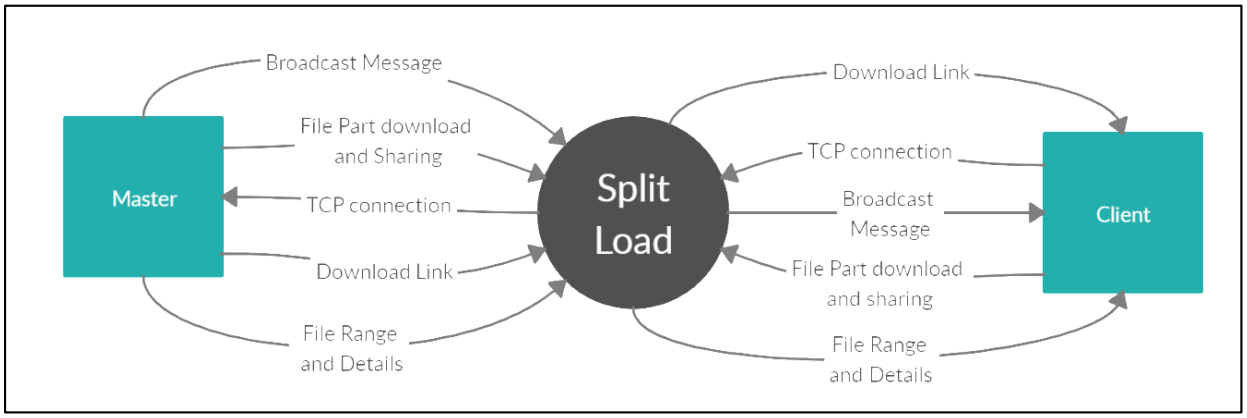
5.2 Detailed Design

5.2.1 Hierarchy of Modules

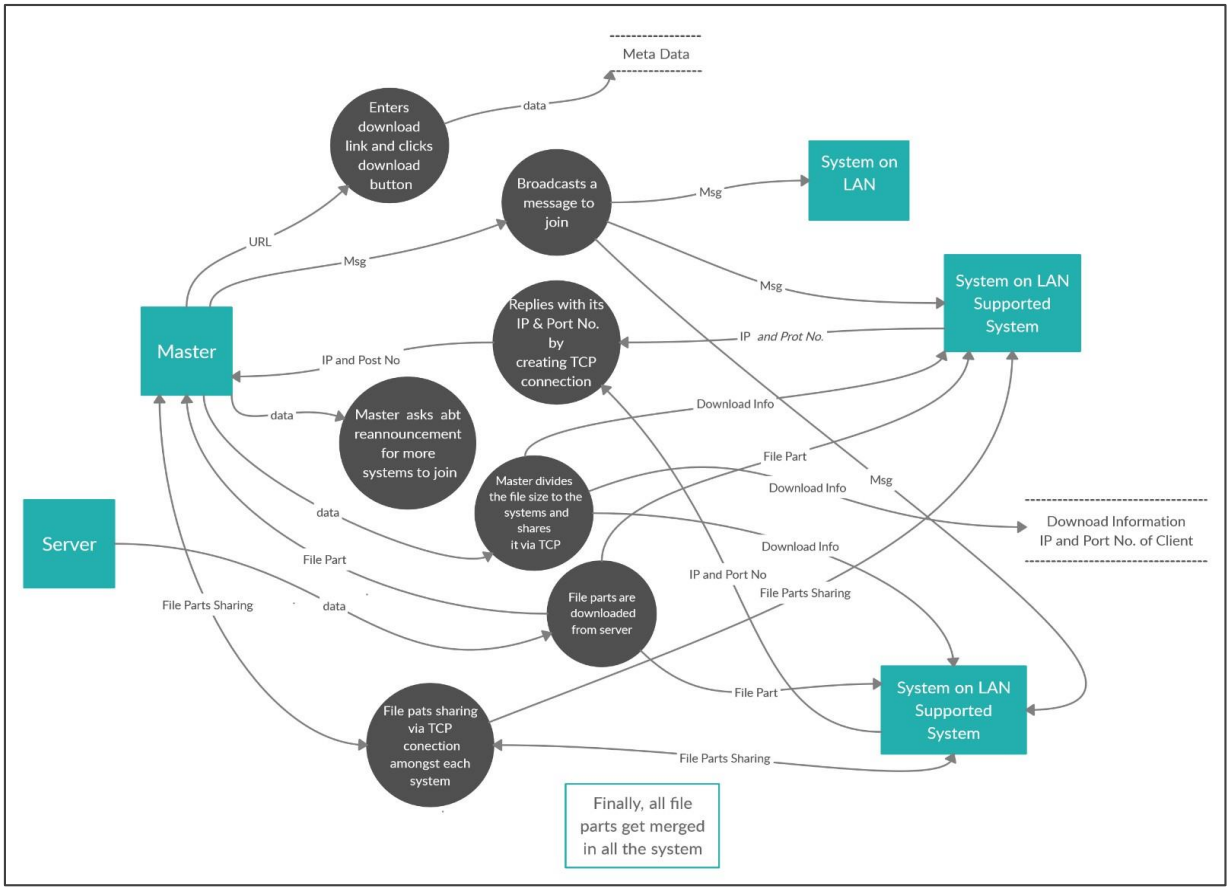


5.2.2 Data Flow Diagram

Level 0:



Level 1:



6 Implementation

6.1 Implementation Details

Our project focuses on download a file in parts in different computers and then sharing the parts over LAN and merging the parts to get the complete file on each and every system. This project can be broken into several modules:

6.2.1 CUI: Creating UI

We create a user interface for the software to make it user friendly such that non-technical people can also use the software. Creating and integrating the UI with the program will prevent the user from using command prompt.

6.2.2 MSD: Master Starts Download

The master system starts the whole process of downloading by clicking on "start" button of the software and enter the URL from which the file must be downloaded.

6.2.3 BMS: Broadcast message sent

A broadcast message is sent to all the systems by the master system which are connected on the same network via LAN.

6.2.4 CTM: Client creates a TCP connection with Master

The systems which have the software and are ready for download on the same network, requests a TCP connection [6] with the master. Master accepts the TCP connection request and saves the IP address of the system requesting the connection.

6.2.5 RCN: Range Calculation

The master divides the file using cURL command and calculates the range i.e. it tells all the systems which system must download which part and shares the download link of the file.

6.2.6 SDL: Sharing of Download Links

After the connection is setup, the master shares the information of download link and range of the file.

6.2.7 TCC: TCP Mesh Connection amongst the Client

After sharing of link, all clients create a TCP connection amongst each other involved so that it can share its downloaded part with other systems.

6.2.8 TCT: TCP connection Tuning

TCP connection is enhanced by incorporating features of UDP connection to enhance the speed of download and share.

6.2.9 DFP: Downloading of the File Parts

After the TCP connection has been built, all the systems start downloading the file parts.

6.2.10 SFP: Sharing of the File Parts

All the systems start sharing and receiving the part of the file while the file parts are getting downloaded.

6.2.11 MPF: Merging of all the parts of the file

After receiving all the parts from all the systems i.e., after sharing and downloading of the files is over, merging of the files starts with the help of copy command line tool. It merges the sperate parts of the same files in each system.

6.2.12 FPS: Free Port Service

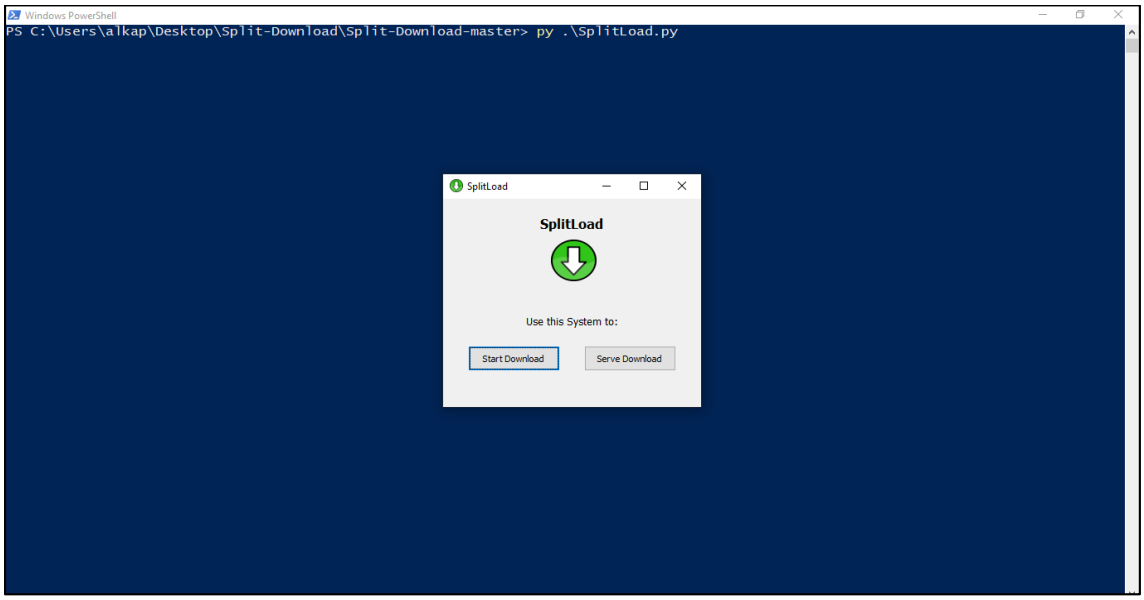
This can be used to get a free TCP port from the system.

6.2 System Installation Steps

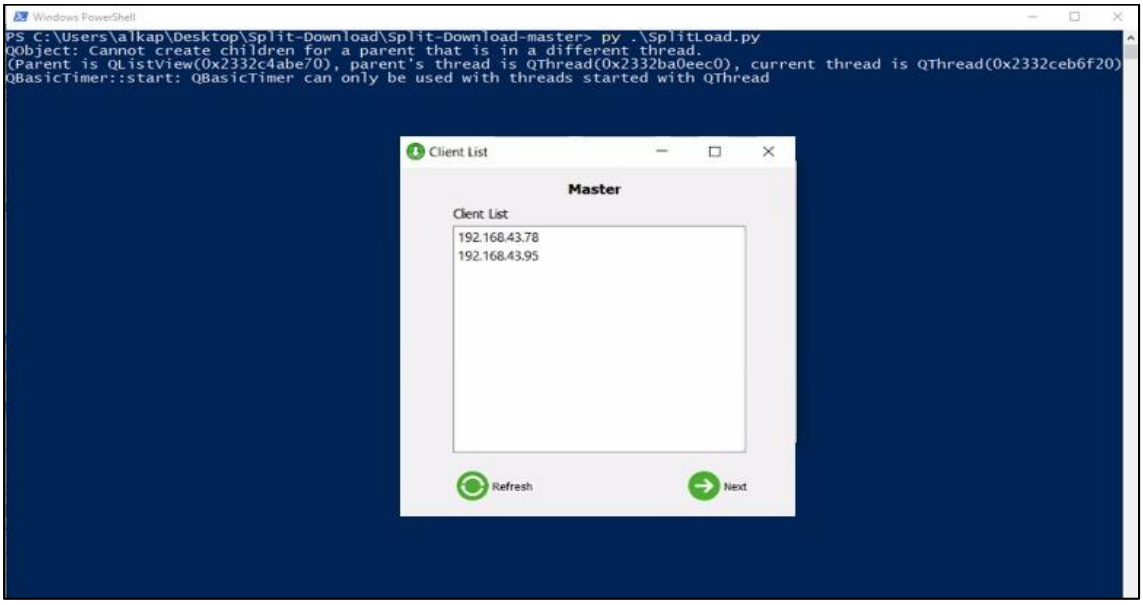
- Download and install Python 3.x on the system and ensure to add the path in the environment variable.
- Open command prompt and navigate to the project folder.
- Install “requests” from command prompt using the command “pip install requests”.
- Install “pyQt5” from command prompt using command “pip install pyQt5”.
- Install “enlighten” from command prompt using command “pip install enlighten”.
- Now start the project using the command “py SplitLoad.py”.
- The project is now up and running.

6.3 System Usage Instructions

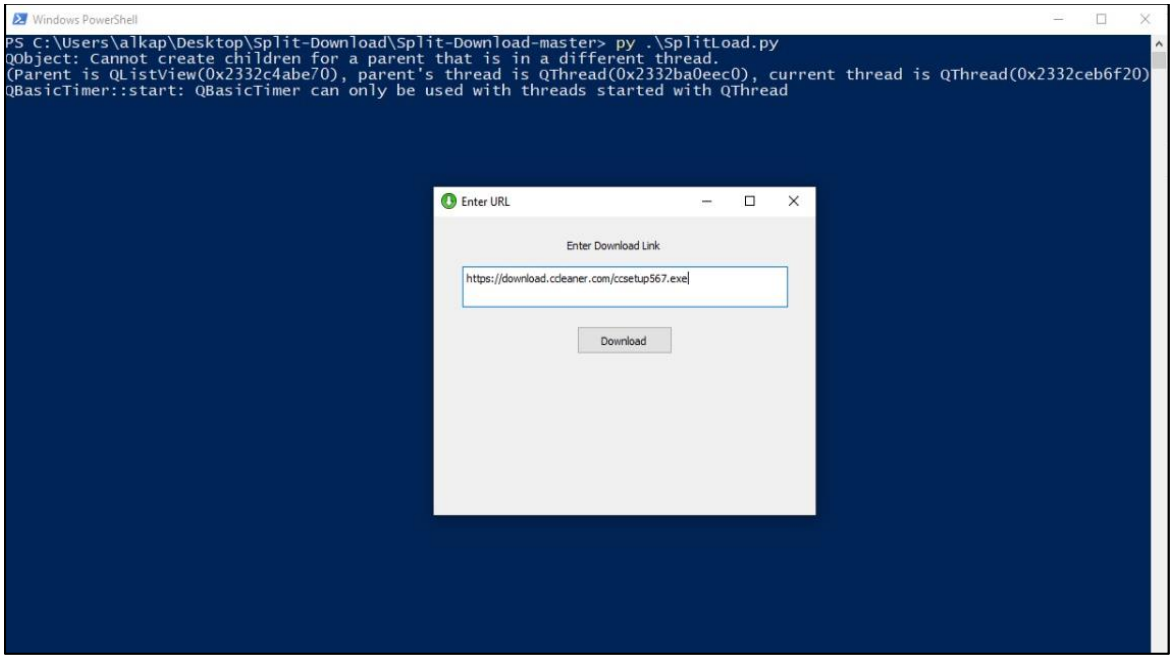
- A UI pops up with options of Start Download and Serve Download. All the respective clients press the Serve Download button.



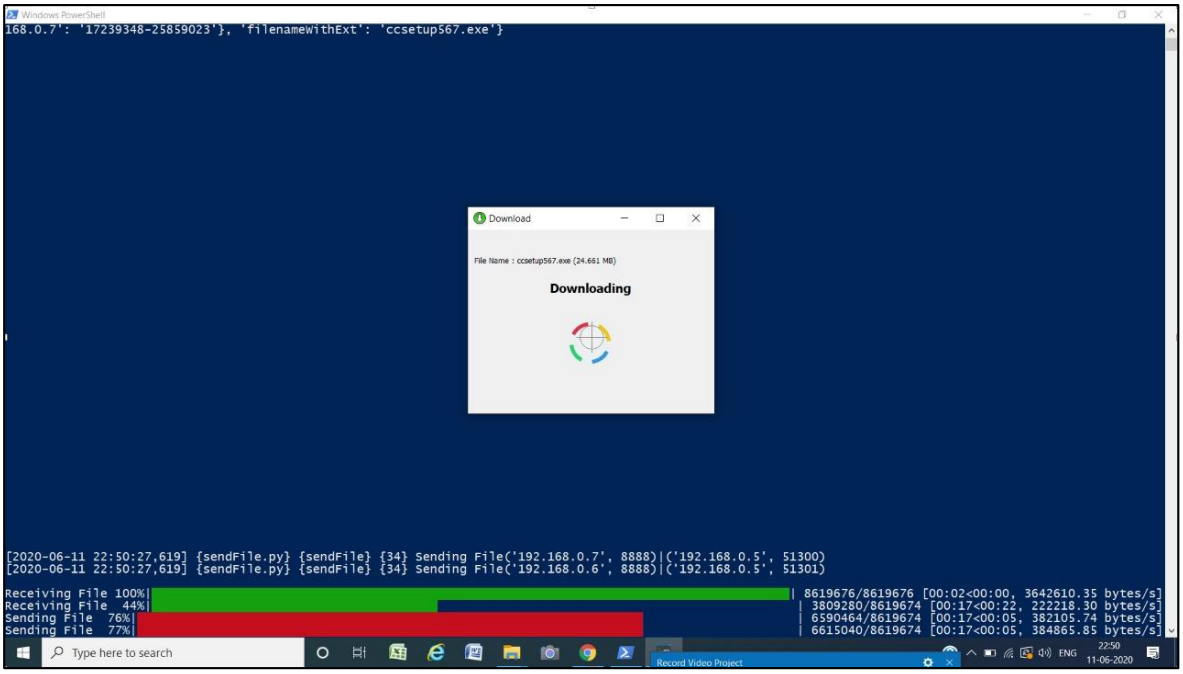
- The master on the other hand presses the Start Download option and obtains the list of the IPs of the respective clients.



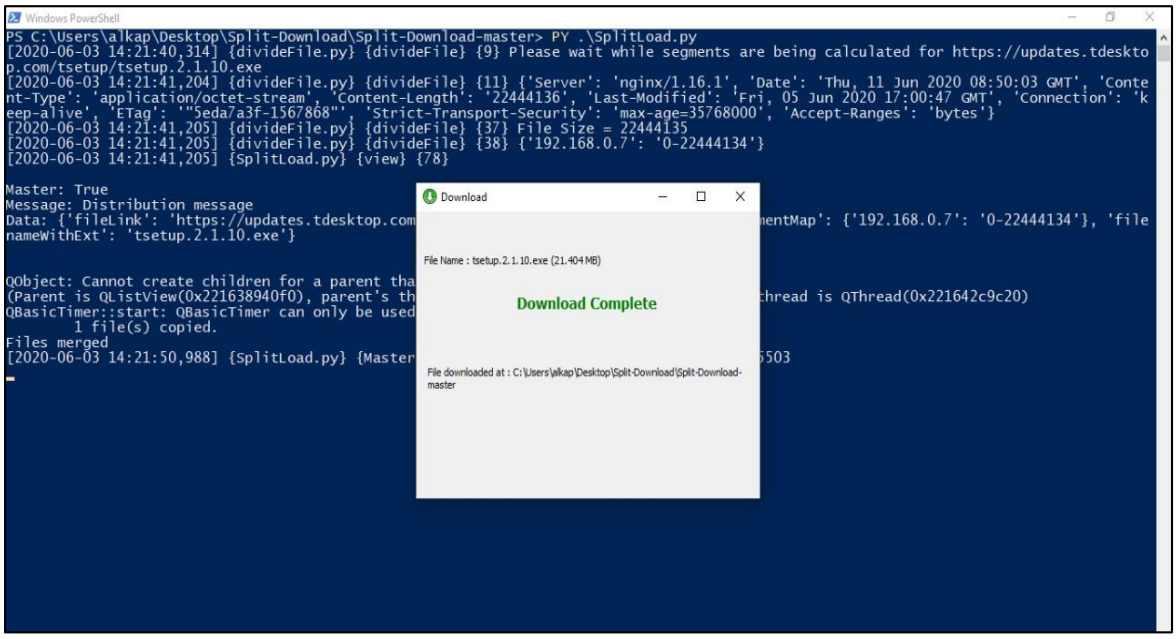
- Upon clicking the Next button in the previous pop up a new UI is presented with an option to enter the download link of the file that needs to be downloaded in all the systems.



- As the download button gets clicked the file starts downloading and simultaneous sharing begins in all the systems.



- The download gets completed and shared in all the systems. The filename with its size and the location where the file is downloaded in the respective systems are presented.



7 Test Results and Analysis

7.1 Test Plan

Test Case Number	Test Case	Input	Result	Status
T-MSD-1.2	Master Initiates Download Procedure	Download link	Download starts	Completed
T-BMS-1.3	Broadcast Message sent	Master initiates the message	Message received	Completed
T-CTM-1.4	Client creates a TCP connection with Master	Initiation for TCP connection creation	Master creates the TCP connection	Completed
T-RCN-1.5	Range calculation	cURL command divides the file	File gets divided equally	Completed
T-SDL-1.6	Sharing of download link	Master shares information with the clients	Link is shared	Completed
T-TCC-17	TCP Mesh Connection amongst the Client	All client creates TCP connection with each other	TCP mesh connection is created	Completed
T-TPT-1.8	TCP parameters tuning	Enhancing TCP connection to improve speed		In Progress
T-DFP-1.9	Downloading of the File parts	All systems download the file parts	Downloading completed	Completed
T-SFP-1.10	Sharing of the File parts	All systems share file parts while they are being downloaded	Sharing completed	Completed
T-MPF-1.11	Merging of all parts of the file	All the parts from every client starts to merge	Complete file on each system	Completed
T-FPS-1.12	Free Port Service	Get a free TCP port	Free TCP port	Completed

8 Conclusion

Most of the time, the bandwidth provided by the ISP is under-utilized. While the CPU processes each packet, the next packets wait to be processed. The Project removes this bottleneck providing the processing power of several computers at a time. It also implements the concept of torrent to merge the files. This technique has already been proven to be reliable and successful. Hence, the software can prove to be quite useful in many scenarios.

8.1 Project Benefits

Most of the organizations have several computers on their local network. Downloading and transferring a file to all those computers is a slow and tedious task. Even if we download a file somewhere and share it on the LAN, each computer must manually download it.
The Project improves the downloading speed by utilizing the full bandwidth of the network. The task of downloading a file is divided amongst many computers. Each one downloads its assigned part and efficiently merges it to provide an easy to use, one stop solution for downloading as well as sharing the file wherever required on the LAN. The USP of the software is that it's one of a kind. It can have a huge impact in the corporate as well as educational institutions.

8.2 Future Scope for improvements

While creating our project, to increase the efficiency and to decrease the complexity, we have made certain exclusion. We have not yet incorporated an algorithm to distribute the load if a node or a series of nodes crashes. Also, our project excludes the algorithm to support simultaneous multiple file downloads.

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