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Design and Development of Application to Transport Layer Protocol for Smart Collaboration of Intelligent Devices

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Abstract— There are varieties of smart devices – devices with hardware and significant amount of software to mine data from the hardware in and around us, like in Home we have smart phones, smart TV, Laptops, smart refrigerators, etc. There is a need for each device of different size and capability to collaborate. That brings us to first and most important step of "inter- device communication", which can be deployed on any device without much further fuss. Simple yet secure channel of communication, which does not require much of computing power or memory is real time in nature and is extensible towards future. The challenge is to develop a simple Application Layer protocol, which uses existing TCP/IP technology to interconnect these devices and enable bi-directional communication, which is minimalistic in terms of size of payloads – data available at each of these smart devices- and will use the WWW (world wide web's) most versatile tool – XML for making encoding data/information in a format that is both human-readable and machine-readable

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I. INTRODUCTION

There are varieties of smart devices – devices with hardware and significant amount of software to mine data from the hardware in and around us, like in Home we have smart phones, smart TV, Laptops, smart refrigerators, ACs, Motor , Washing machines and fans and music system just to name a few. The challenge is each device is designed and developed to do its intended function very well and each is from different brands. Each brand competes with each other and so less of collaboration in terms of using each device better to make our life "smarter". The above scenario of "smart Home" is intended to be one of the 'use case' for the protocol library and small application plugin based on library built on top of the library to add "networking and communication" in smart devices all around us. The objective is to lay the foundation for all other such collection of devices present in our surroundings like "office", "industrial setups" as well as "public setups – like emergency warning systems, information systems" etc

II. EXISTING TECHNOLOGIES

We first describe some common types of communication technologies:

1. Wi-Fi, DLAN

The DLAN is an industrial organization whos job is to publish guidelines covering basic protocols and media formats from which we can achieve interoperability among household electrical appliances, portable devices, and home network for the purpose of sharing data forms and content .The DLAN guidelines specifies Universal Plug and Play (UPnP) for the discovery of device , content selection and display, Hyper Text Transfer protocol (HTTP) and Real-time Transport Protocol (RTP) are used for performing media transfer, TCP/IP is used for network connectivity .

2. Bluetooth, Bluetooth Low Energy (BLE)

The Bluetooth wireless communication standard, which uses the 2.4-GHz band is presently being transitioned to the next-generation versions. Version 3.0 High Speed (3.0 +HS) features with higher throughput (up to 24 Mb/s) and version 4.0 features BLE function, which significantly reduces power consumption. In Bluetooth 3.0 "enhanced power control" and supports "unicast connectionless data" are included .The fourth version Bluetooth 4.0 has limited communication speed of only 1Mb/significantly saves power by adding BLE function.

3. NFC

Short-distance wireless communication standard is used in the NFC of 13.56-MHz band. With NFC, simply bringing two devices close to each other allows communications.

III. LIMITATIONS OF EXISTING TECHNOLOGIES

- Wi-Fi trouble in connection of cellular devices
- TCP invokes the slow-start mechanism. If the network links are slow, the congestion window grows after a long time.
- Wireless links possess high bit error rates. Channel fading and handoff during motion of mobile nodes are major causes for temporary disconnections. Both the link level handoff protocol being used as well as the IP level handoff protocol being used is the dependency of handoff period , if any.

IV. PROPOSED TECHNOLOGY

Protocol – Scope:

To define a data protocol, scope of its Two components are needed to broadly defined – messaging and interactions.

Messaging:

- Data Model
- Encodings

Interactions:

- Message Sequencing
- Use cases

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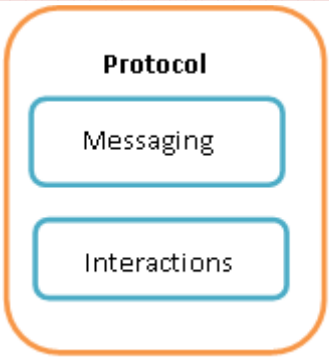


The data Model is represented in XML and has the following Characteristics:

- XML elements represent data Values or group of data values.
- XML Attributes provide standard and extended meta data about the elements.
- An element is either:
- A data Element that represents measured values.
- A grouping element that contains a list of child elements which are data elements or other grouping elements.

V. COMMUNICATION SEQUENCE WITH ANOTHER DEVICE

"Client" Devices:

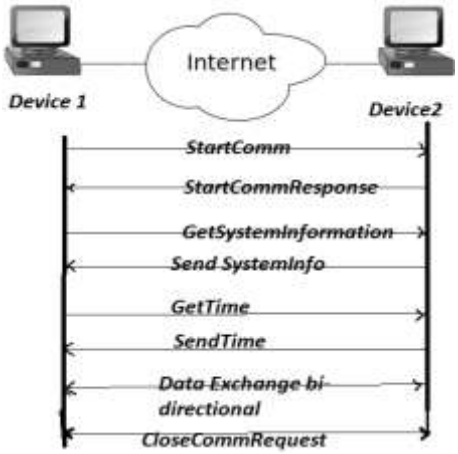
A device that is the primary destination of data in the interaction, commonly referred to as the "client" device in client-server Interaction.

"Server" Devices:

A device that is the primary source of data in the interaction ,commonly referred to as the "Server" device in client-server Interaction.

"Gateway Server" Device:

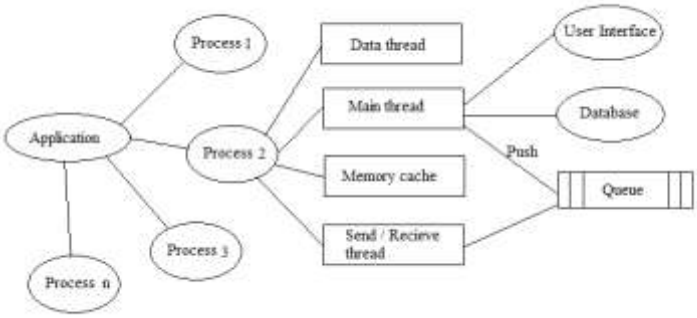
This is a specific type of "Server Device" that is primary source of data in the interaction. Providing data for multiple connected Clients is one of the distinguishing features of this device.



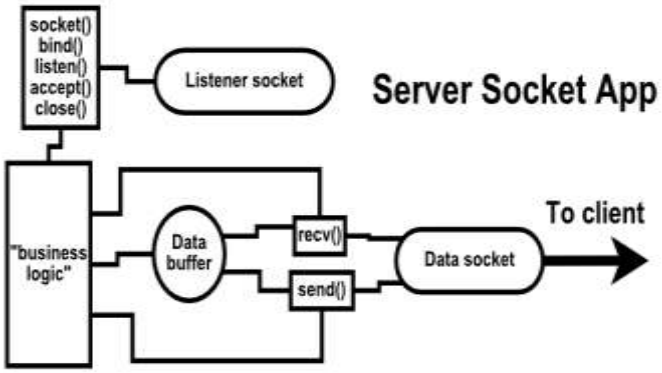
VI. DESIGN MODEL

This project envisages supporting and building the information highway by way of standardized communication and associated infrastructure is intended to be used as is, instead of creating a new one which will rise costs and becomes a huge burden while implementing large scale projects which can save energy, human efforts, reduce downtime, help in preventive maintenance and efficient delivery of services, with better yet scope for more Value Added Services (VAS).

Main application in any given system will work in accordance with cache and queue with the main thread operating as the activity holder maintaining the various push operations. Queue holds various send and receive threads. Main thread takes input from the user through user interface while considering the data stored in database to reduce redundancy.



Here the idea is that a message producer sends out a message through a message queue, and lots of message consumers compete to grab and service that message. In so doing, the message producer can offload non-time-critical work to other resources in order to continue interacting with the user at lightning speed, and also distributing the load. This yields benefits in performance ,scaling and graceful degradation (doesn't crash). Many specific jobs can be programmed in a distributed manner using sockets.



Sockets are an excellent thin interface. They're the basis of most client/server applications. They can easily be used to separate data from user interface from logic. These logic are shown as client and server socket app. However, the fact that a Unix domain socket server cannot be accessed remotely yields some security benefits. Adding to those security benefits is the fact that client access can be controlled by user by changing ownership and permissions on the filename to which the server's listener socket is bound.

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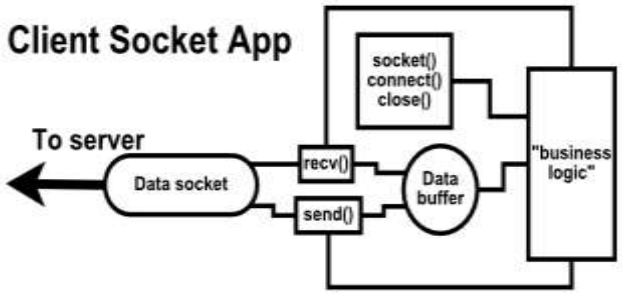

VII. Transport and Network Layer Protocols Survey

1. Real-Time Transport Protocol

Real-Time Transport Protocol or RTP is used to provide end-to-end delivery services for data with real-time characteristics (such as audio and video data). The original designing of RTP was done as a thin protocol for multi-participant multimedia conferences, using the underlying multicast support within the network layer. No Quality-of-Service (QoS) guarantee is provided, nor does it provide in-order delivery of packets. UDP is used in RTP as its transport there by having disadvantages.

2. Stream Control Transport Protocol

The Stream Control Transport Protocol (SCTP) is a reliable transport protocol that operates over IP. It was designed for message-oriented applications and operates as a stream of messages instead of a stream of bytes (such as in TCP).While SCTP can be configured to operate as UDP or TCP, it offers some very interesting features to the application layer. The more important features are discussed next. SCTP supports multiple delivery modes. SCTP can support strict order-of-transmission behavior as exhibited by TCP (including retransmission) or it can support unordered delivery as exhibited by UDP.

3. IP Next Generation

The Simple Internet Protocol Plus, or SIPP, is a network layer protocol that is interoperable with IPv4. It solves the immediate addressing problem that exists with IPv4 (running out of addresses) using hierarchical addresses (with 64-bit addresses instead of IPv4's 32-bit scheme). SIPP also provides local-use addresses that provide "plug-and-play" capabilities. SIPP also includes Quality of Service (QoS) features such as traffic flows with special handling constraints through packet labeling. Other useful features include authentication and privacy with support for data integrity and confidentiality.

VIII. QOS Characteristics

The purpose of QoS is to effectively manage the available bandwidth using a number of related constraints. These constraints are as follows:

•Minimizing inter-packet delay (throughput),
•Minimizing packet inter-arrival variations (jitter),
•Minimizing dropped packets (loss),
•Minimizing per-packet charges, (cost)
•Minimizing packet tampering or eavesdropping (security)

IX. Internet Security

IPSec is a framework of open standards for network security consisting of a network layer protocol that provides interoperable cryptographically-based security for the Internet Protocol. IPSec provides access control, data origin authentication and encryption of the IP payload thereby protecting upper layer protocols. IPSec provides security using two specific mechanisms, the Authentication Header (AH) and the Encapsulating Security Payload (ESP). Both the AH and ESP are contained within the IP datagram.

The Secure Sockets Layer (or SSL) is a new sockets interface that exists between the transport protocol and the application layer protocol. SSL is a layer 4+ protocol that sits on top of the TCP layer. SSL provides for compression of data, authentication and encryption

X. LITERATURE SURVEY

Wireless links have high bit error rates. Also, temporary disconnections occur because of the factors like channel fading, and handoffs when a mobile node is in motion. The handoff period depends on both the link level handoff protocol being used as well as the IP level handoff protocol being used, if any. The Idea for a protocol for Smart collaboration is inspired by an array of independent yet having common theme of – collaboration of states and data available on one device to another for better decision making - “Home Automation”, Mobile –car Integration systems, “Smart industrial Grids” and at a larger scale “Smart Cities like Kyoto in Japan”.

[1] Toshiya Tamura, Isao Masuda “Device connectivity technologies using short distance wireless communications” Fujitsu Sci Tech.J, Vol 4,No 2(April 2013).“In this paper we get an overview of short-distance wireless communication technologies and the applied approach of connecting smartphones to audio-visual devices, in-vehicle devices, and the healthcare devices which utilizes the application of those technologies.”

[2] R Krikorian and N Gershenfeld “Internet 0 — inter-device internetworking” BT Technology Journal • Vol 22 No 4 • October 2004.“The assumptions on which internet architectures are formed do not favor small devices — they include a baseline cost that is still pretty large for small, few-dollar, embedded objects. This barrier tends to leave many devices network disenfranchised or it encourages the formation of segmented networks. The attempt of Internet 0 is to enable pervasive computing and networking on the embedded level by supplying the Internet protocol as a communications substrate, and, through the use of an end-to-end modulation scheme, to communicate with devices. I0 is a framework designed to bridge together heterogeneous devices via IP in such a manner that it is still compatible with the design of globally large computer networks.”

XI. CONCLUSION

This protocol provides user with easy and efficient way to communicate two smart devices through TCP/IP and enables a bidirectional communication between these devices. In future this protocol can be extended to be like a

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generic protocol which can be deployed on any type of devices, so it removes the problem of collaboration between the devices. it provides a secure channel of communication, which does not require much of computing power or memory and is real time in nature and is extensible towards future.so in all over term it increases the performance and efficiency of the system and lowers the cost. In implementation the system is designed with library that contains all the function that is needed for an application or device in order to communicate with each other. In future using this library new application with desired functionality can be built and deployed on any type of devices.

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