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Internet of Things

Assignment 2

Q.1 What are different data formats found in IoT network traffic streams?

IoT connects any 'thing' that generates data to internet. Internet contains a lot of data in the form of videos, images, text, e-mails, audio, etc. The major data formats generated by IoT sensors and applications are:

i) Text
ii) Binary
iii) Extensible Markup Language (XML)
(iv) Comma-Separated Values (CSV)
(v) Java Script Object Notation (JSON)
(vi) Radio Frequency Identification (RFID)

Q.2 Depending on urgency of data processing, how are IoT data classified?

Depending on urgency of data processing, IoT data is classified into 3 types:

(i) Very Time Critical: Data from Sources which need immediate decision support. These data

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have a very low threshold of latency (processing or transmission), typically in the range of a few milliseconds. Ex. Flight control system, healthcare system etc.

(ii) <u>Time-Critical</u>: Data from sources that can tolerate normal processing latency. These data can tolerate a latency of a few seconds. Ex. data from traffic, smart homes, etc.

(iii) <u>Normal Data</u>: Data from sources that can tolerate a processing latency of a few minutes to few hours. Ex. Agriculture, environment monitoring etc.

Q-3 Highlight the pros and cons of on-site and off-site processing?

(i) <u>On-site Processing</u>:

<u>Pros</u>: Data is processed at the source itself and thus there are very low processing latencies; suitable for very-time critical ~~sp~~ data.

<u>Cons</u>: These show temporal changes that can be missed unless the processing infrastructure is fast and robust enough to handle such data.

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(ii) Off-site Processing:

Pros: It allows processing and network latencies, hence suitable for IoT deployments that have low ~~scale~~ demands and are large scale.
It is significantly cheaper than on-site processing as there is no need to process data on urgent basis and hence providing processing power to each sensor node.

Cons: It can't be used for time-critical or very-time critical data as they have lower threshold for latencies.

Q.4 How is collaborative processing different from remote processing?

Remote Processing:
i) It encompasses sensing of data by various nodes, then forwarding this data to a remote server or cloud-based infrastructure for processing.

(ii) Processing from thousands of nodes can be offloaded to a single, powerful computing platform, hence cost effective.

(iii) the setup ensures massive scalability
(iv) uses up a lot of network bandwidth
(v) network latencies in processing.

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Collaborative Processing :

(i) The processing power of nearby processing nodes is clubbed together and data is processed collaboratively in the vicinity to the source itself.

(ii) economical for large-scale deployments over vast areas, where providing network access to a remote infrastructure is not viable

(iii) it uses mesh network among nodes.
(iv) it conserves bandwidth of the network
(v) it reduces latencies due to transfer of data over network.

Q.5 What factors are to be considered while deciding on the data offload location?

The following factors are to be considered while deciding the data offload condition:

(i) **Bandwidth**: The maximum amount of data that can be simultaneously transmitted over the network between two nodes. It is also known as data-carrying capacity.

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(ii) Latency: Time delay incurred between start and completion of an operation. It occurs due to network or processor. In either case, it arises due to physical limitations of the infrastructure.

(iii) Criticality: It defines the importance of a task being pursued by an IoT application. Higher the criticality, lower must be latency.

(iv) Resources: It signifies the actual capabilities of an offload location. These capabilities may be processing power, memory etc.

(v) Data Volume: The maximum amount of data that can be processed by an offload location simultaneously.

Q.6 Differentiate between structured and ~~non~~ unstructured data.

(1) Structured Data:
(i) have a pre-defined structure
(ii) associated with relational DBMS
(iii) created by using fixed length fields
(iv) easily searchable by querying algorithms
(v) holds a minor share in IoT
(vi) Ex. Flight Reservation System, Banking system etc.

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(II) Unstructured Data :

(i) have no pre-defined structure
(ii) associated with cloud / server
(iii) e-mails, videos, audios, images etc.
(iv) are not easily searchable by querying algorithms
(v) holds a major share in IoT
(vi) Ex. Sensor data from traffic, building etc.

Q.7 What are the critical factors to be considered during the design of IoT device?

The critical factors to be considered during the design of IoT device are:

(i) Size : It decides form factor and energy consumption of a sensor node. Larger the form factor, higher is energy consumption.

(ii) Energy : Higher energy requirements means higher energy source replacement frequency. This automatically lowers the long-term sustainability of sensing hardware.

(iii) Cost : Cheaper cost of hardware enables a much higher density of hardware deployment.

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(iv) Memory : It determines the capabilities the device can be armed with. Features such as local data processing and data storage rely heavily on memory.

(v) Processing Power : It is vital in deciding what type of sensors can be accomodated with the IoT node, and what processing features can integrate on-site with the device.

(vi) I/O Rating : It helps in determining the circuit complexity, energy usage and requirements for support of various sensing solutions and sensor types.

(vii) Add Ons : IoT device provide add ons such as analog to digital conversion units, in-built clock circuits, connection to the USB and ethernet, etc.

Q.② What are the data offload locations available in IoT?

Various data offload locations available in IoT are:

(i) Edge : It implies that the data processing is facilitated to a location at or near the source of data generation itself.

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(ii) Fog: It is a decentralized computing infrastructure. The data, computing and storage are shifted to a place between the data source and cloud resulting in significantly reduced latencies and network bandwidth usage.

(iii) Remote Server: A simple remote server with good processing power may be used with IoT ~~devices~~ applications to offload processing from resource constrained IoT-device.

(iv) Cloud Computing: It is a configurable computer system, which can get access to configurable resources, platforms, and high-level services through a shared pool hosted remotely.

Q.9 What are various decision making approaches chosen for offloading data in IoT?

There are three approaches:

(i) Naive Approach: A hard approach, without too much decision making. It can be considered as a rule-based approach in which the data from IoT devices are offloaded to nearest location based on achievement of certain offload

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criteria. Generally, statistical measures are consulted for generating the rules of offload decision making.

(ii) Bargaining based Approach: A bit processing intensive during the decision making stages. At times, while trying to maximize multiple parameters for the whole IoT implementation, in order to provide most optimal QoS, not all parameters can be treated with equal importance. Bargaining based solutions try to maximize QoS by reducing qualities of certain parameters and enhancing it for others.
This approach does not depend on historical data for decision making. Ex. Gaming Theory.

(iii) Learning Based Approach: These generally rely on past behaviour and trends of data flow through the IoT architecture. The optimization of QoS parameters is pursued by learning from historical trends and trying to optimize previous solutions further. Ex. Machine Learning.

Q.10 Why process offload paradigm is important in IoT?

Process offload paradigm is important in IoT for the development of densely deployable,

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energy conserving, miniaturized, and cheap IoT based solutions.
It includes offloading data to various offloading locations:
(i) Edge Processing
(ii) Fog Processing
(iii) Local or On-site processing
(iv) Cloud Computing.