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A COMPARATIVE STUDY OF MODERN NETWORK CONCEPTS

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ABSTRACT

This paper attempts to document the comparative study of modern networking concepts employed today viz. mobile networks, cloud computing networks and personal networks that have been designed to meet the users' needs and interconnect users' devices equipped with different communication technologies in various places to form one network.

CLOUD COMPUTING NETWORKS

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can rapidly be provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.

Essential characteristics

On-demand self-service	A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.
Broad network access	Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogenous thin or thick client platforms (e.g., mobile phones, tablets, laptops and workstations)
Resource pooling	The provider's computing resources are pooled to serve multiple

consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the consumer generally has no control or knowledge over the exact abstraction (e.g., country, state or datacenter). Example of resources include storage, processing, memory and network bandwidth.

Rapid elasticity — Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

Measured service — Cloud systems automatically control and optimise resources use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth and active user accounts). Resource usage can be monitored, controlled and reported, providing transparency for both the provider and consumer of the utilised services.

Service Models

Software as a Service (SaaS) The capability provided to the consumer is to use the provider's applications running on a cloud's infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure, including network, servers, operating systems, storage or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Platform as a Service (PaaS) The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

Infrastructure as a Service (IaaS) The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computer resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

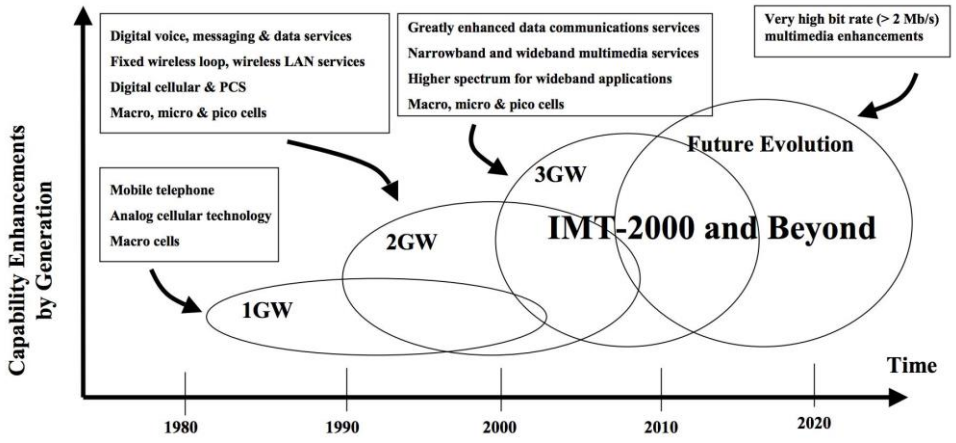
Deployment Models

Private Cloud — The cloud infrastructure is provisioned for excessive use by a single organisation comprising multiple consumers (e.g., business units). It may be owned, managed and operated by the organisation, a third party, or some combination of them, and it may exist on or off premises.

Community Cloud — The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organisations that have shared concerns (e.g., mission, security requirements, policy and compliance

	considerations). It may be owned, managed and operated by one or more of the organisations in the community, a third party, or some combination of them, and it may exist on or off premises.
Public Cloud	The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed and operated by a business, academic, or government organisation or some combination of them. It exists on the premises of the provider.
Hybrid Cloud	The cloud infrastructure is a composition of two or more distinct cloud infrastructures that remain unique entities, but are bound together by standardised or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

MOBILE NETWORKING CONCEPTS

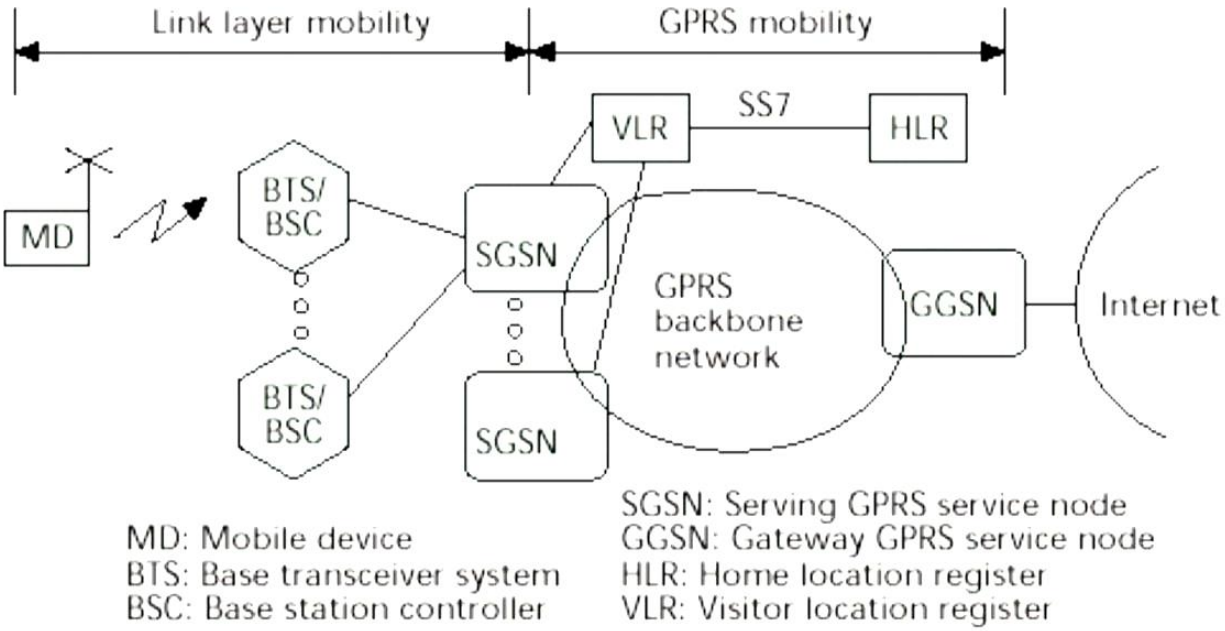


GSM — Global System for Mobile Communication

Configuration	MS : ME (IMEI — International Mobile Equipment Identity) + SIM (IMSI International Mobile Subscriber entity) BSS : BTS (Radio transceiving, Handling radio-link protocols) + BSC (Radio channel setup, frequency hoping, handover) NS : Handling subscriber (user using SS7, registration, authentication, location updating, handover, call routing to a roaming) + Switching (connecting to fixed net).
Air Link	Uplink (890-915 MHz)/Downlink (935-960 MHz) FDMA (25MHz = 124 carriers x 200 kHz) + TDMA (burst period : 15/26 ms)

GPRS — General Packet Radio System for GSM

Configuration	MS, BS, GSN/VLR/HLR, GSN — GPRS Support Node SGSN — serving GSN Node, GGSN — Gateway GSN Node
Air Link Interface	GMSK —> EDGE —> WCDMA Paging — battery power reduced Registration, authentication, handoff



The I — 95 CDMA Mobile Network

IS — 95	TIA interim standard for digital cellular communication system.
TDMA + CDMA	800 (cellular), 1.7 — 1.8 MHz (PCS)
CDMA	High capacity, small cell radius, spread spectrum technology, special coding scheme.

RAN (Random Access Network), PCF (Packet Control Function), PDSN (Packet Data Servicing Node).

Mobile — IP

- Connectionless packet delivery
- Unreliable delivery
- IP host addresses consists of two parts — Network ID and host ID
- By design, host address is tied to its network
- Intermediate routers need only look at the network ID
- Destination network responsible for getting packet to right host
- When a host moves to a new network, its IP address would have to change, packets to old address are lost

IETF Mobile IP Protocol

- IETF (Internet Engineering Task Force) : Standards development body for the internet
- Mobile IP allows a host to have a unique (location-independent) IP address
- Each host has a home agent on its home network that forwards IP packets when mobile host away from house
- When away from home, mobile host has a care-of-address, which is the address of foreign agent within the foreign subnet — the foreign agent delivers forwarded packets to mobile host. It may also be a temporary IP address on the foreign network
- When moving, the host registers with home agent since it always knows the host's current care-of-address

- A correspondent host is a host that wants to send packets to the mobile host. It sends packets to the host's Mobile IP address, which are routed to the host's home network. It need not know that the destination is mobile

- Home agent encapsulates and tunnels packets to the mobile host's care-of-address

Encapsulation and Tunneling

- IP-in-IP encapsulation
- Received IP packet in encapsulated in a new IP packet with a new header that contains: destination (care-of-address), source (address of home agent) and protocol number (IP-in-IP).
- Decapsulation protocol at foreign agent removes added header, transmits the packet to the mobile host over the local network interface (be it wire-line or wireless).

Minimal Encapsulation

- Reduces the additional bytes added to header when encapsulating — 8 or 12 bytes are added.
- Original source address need not be included in the tunnel header, if the original source is also the tunnelling node.

MosquitoNet

- No foreign agent
- Visiting mobile host is assigned a temporary IP address corresponding to the foreign subnet
- Packets are tunnelled directly to the mobile host (without having to go through a foreign agent)

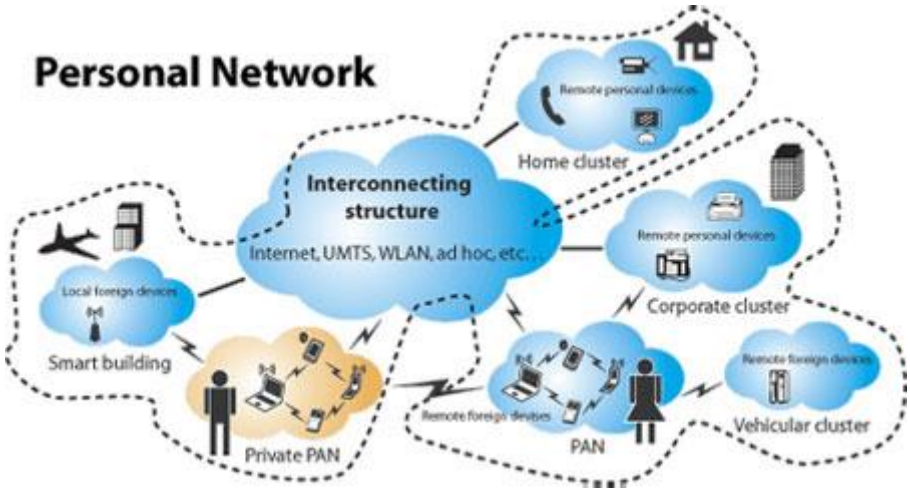
Advantages	Mobile hosts can visit networks that do not have foreign agents Foreign agent is no more a single point of failure Scalability — foreign agent not needed on every network that a mobile may visit. Home agents only needed on networks with mobile clients Simpler protocol — only part of foreign agent functionality is needed
Disadvantages	Mobile host needs to acquire a temporary ID on foreign subnet Security — if a temporary IP address is re-assigned to another mobile host a little too soon, the new mobile host may receive packets intended for the pervious IP owner Packet loss — Foreign agents can forward packets destined for a mobile host that has moved to another foreign subnet. Without foreign agents, the packets will simply be dropped (lost) Mobile host is more complex in MosquitoNet (MosqNet), as it must incorporate some of the functionality of a foreign agent

PERSONAL NETWORKS

Accurate, reliable and real-time indoor positioning and position-based protocols and services are required in the future generation of communication networks. A positioning systems enables a mobile device to determine its position and makes the position of the device available for position-based services such as navigation, tracking, monitoring, etc. Location information of devices or users could significantly improve the performance of wireless network for network planning, network adaptation, load balancing, etc. Some position-based indoor tracking systems have been

used in hospitals where expensive equipment needs to be tracked to avoid being stolen, and the patients can get guidance to efficiently use the limited medical resources inside complex environments of the hospitals. Indoor navigation systems are also needed in a large public area to provide position indicators for the users. In addition, position information brings benefits to self-organisation and self-formation of ad hoc networks in the future communications systems.

The needs of users are highly addressed by the rapid development of integrated networks and services in personal networks (PNs). Much more attention has been paid to context-aware intelligence services for personal use, which makes the person's behaviours more convenient and simple. Position information in indoor environments is of course an essential part of the contexts. The uncertainty in dynamic and changing indoor environments is reduced by the availability of position information. And valuable position-based applications and services for users in PNs are enabled by location context offered by IPSes in various places such as homes, offices, sports centers, etc.



What is a Personal Network?

To meet the demands of users, personal networks (PNs), interconnect various users' personal devices at different places such as home, office, vehicles, etc. into one single network, which is transparent to the users. Through PNs, users can have global access to public and personal services in different types of networks with their personal devices. Personal devices may be equipped with different cellular and wireless networking technologies including wireless personal area network (WPAN), WLAN and the third-generation (3G) cellular networks. Pas connect personal devices with different networking technologies and form dynamic, private and secure networks. Thus PNs with user-centric perspectives can facilitate personal ubiquitous communications anywhere and at anytime.

The success of PNs is highly dependent on the optimal organisation of the personal devices to achieve efficient communication over various types of communications networks. Using different networking technologies, personal devices in each place form a personal area network (PAN), a vehicle area network, a home area network, a computer area network, etc. Personal devices in the same or different places should cooperate with each other to form one single network for the user. Thus interconnecting numerous types of networks enables personal devices in these networks to communicate with each other and offer flexible personal services.

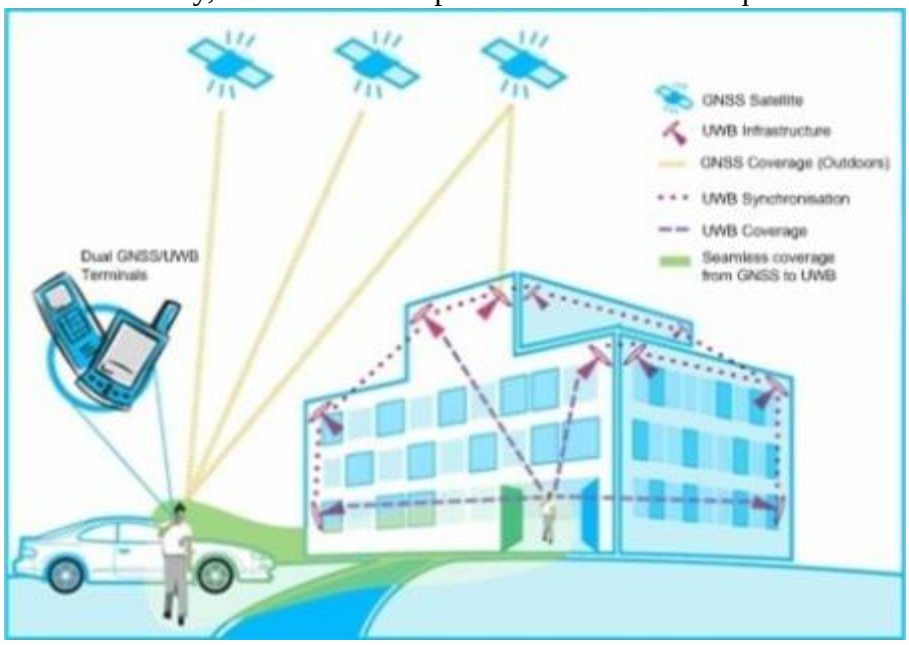
The need of IPS in PN is further illustrated by two typical scenarios, namely fitness centre and conference. These scenarios are selected from a set of scenarios envisioned by the Information Societies and Technologies (IST) MAGNET Beyond project.

1. Fitness Centre Scenario
2. Conference Scenario

Through the use cases, the location context awareness should be implemented in PN services, which offers comfort and efficiency to the end-user. However, IPSes enable location-based services and applications in PNs, which also raise significant security and privacy risks.

What is an Indoor Positioning System?

An indoor positioning system (IPS) considers only indoor environments such as inside a building. The location of users or their devices in PNs can be determined by an IPS by measuring the location of their mobile devices in an indoor environment. An IPS is defined as a system that continuously and in real-time can determine the position of something or someone in a physical space such as in a hospital, a gymnasium, a school, etc. An IPS should work all the time unless the user turns off the system, offer updated position information of the target, estimate positions within a maximum time delay, and cover the expected area the users require to use an IPS.



An IPS can provide different kinds of location information for location-based applications required by the users. The absolute location information is provided by some IPSes. Before the position can be estimated, the map of the location area such as an office, a floor, a building, etc. should be available and saved in the IPS. With respect to the map, the absolute position of a target can be measured and displayed. Usually, the absolute position information with respect to the map of a coverage area is offered by indoor positioning tracking systems and indoor navigation systems, because tracking and guiding services need the exact positions of the targets. The relative position information is another kind of outputs offered by the IPSes, which measure the motion of different parts of a target. The third kind of position information is proximity location information, which specifies the place where a target is. Sometimes, IPSes do not need to provide absolute or relative position information. The position monitoring and tracking systems in hospitals are such examples. The success of IPSes is starting to enable the location-aware computing systems in indoor situations. The system architecture of the location-aware computing systems include three layers — the location sensing system, software location abstractions and the location-based applications. The location-based applications, such as navigating and geographical advertising, are implemented at the highest layer, which use the location context information measured and calculated by the lowered layers.

CONCLUSION

In this paper, we learnt and explored the modern networking concepts like mobile networks, cloud computing networks and personal networks. We learnt that a cellular network or mobile network is a communication network where the last link is wireless, cloud computing network is a type of internet-based computing network that provides shared computer processing resources and data to computers and other devices on demand, and personal network is a computer network used for data transmission amongst devices such as computers, telephones, tablets and personal digital assistants.

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