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Ubiquitous Computing and its Network Requirements

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Ubiquitous Computing

- **What is Ubiquitous Computing ?**
- **Why do we want Ubiquitous Computing to happen ?**
- **How can we facilitate Ubiquitous Computing to happen ?**
- **When can we dare say that computing is ubiquitous ?**

What is Ubiquitous Computing ?

❑ “Ubiquitous Computing”

↔ “Computing existing every where”

❑ It is not about a type of ‘computing’ (such as ‘grid computing’, ‘parallel computing’, ‘pipeline computing’, etc.).

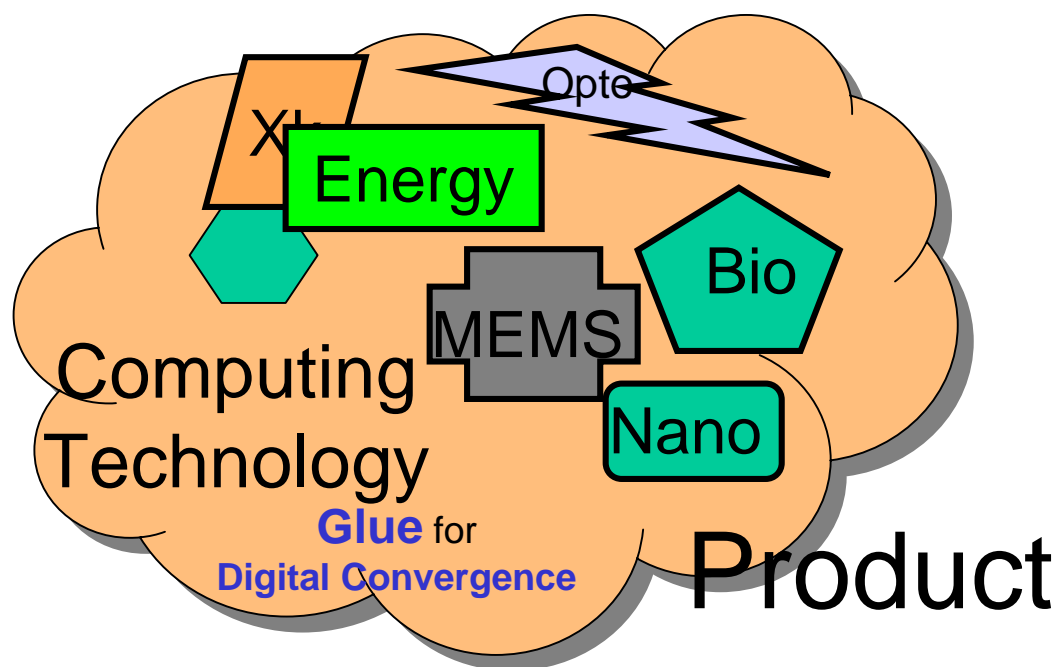
❑ It is a campaign for an IT-flourished society and a visionary description of such a utopia.

- ❑ Ubiquitous computing is not a computing method technology itself; it is just a key attribute of a dream environment for future living in which people will find computing (*not computers*) available everywhere for everything they want to do.
- ❑ ‘Ubiquity’ is a concept about infinity, and ubiquitous computing is realized in practice as a sufficiently progressed *computing dispersion*.

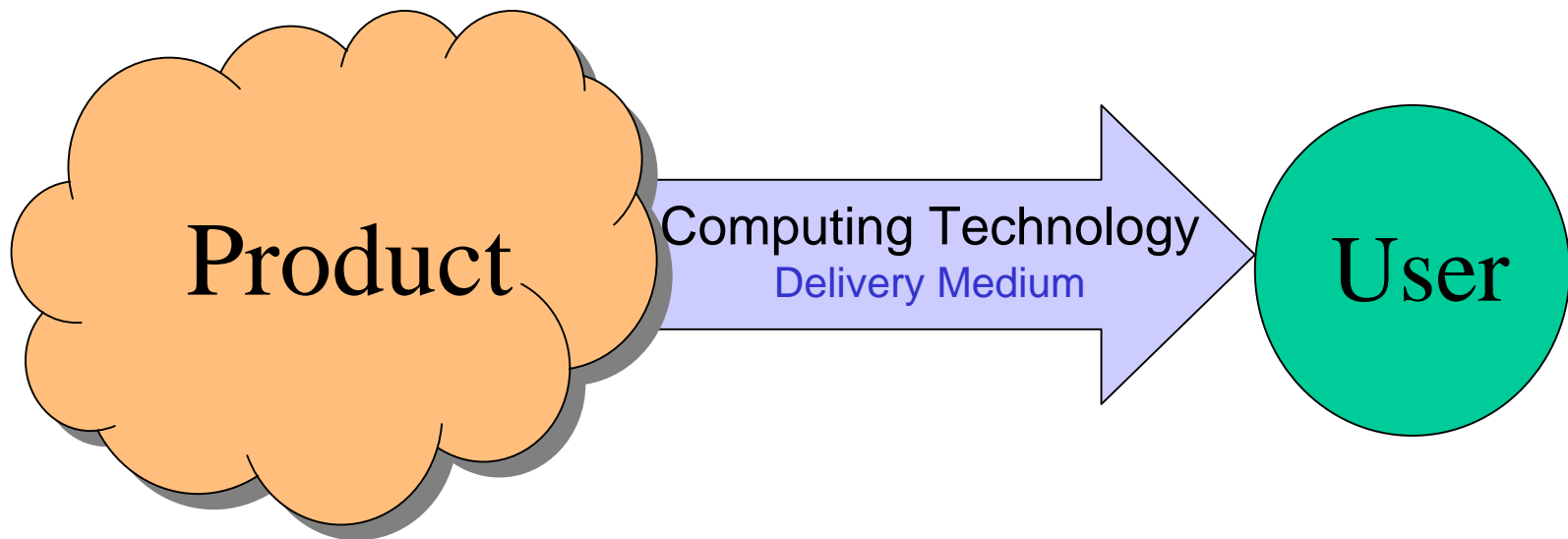
- ❑ ‘Ubiquitous computing’ and ‘ubiquitous anything else’ (including ubiquitous networking) are not more inter-related simply because of their ubiquity than *ubiquitous air* and *ubiquitous water* are.
- ❑ Ubiquitous computing requires good networking connections, but not necessarily ‘ubiquitous networking’.

Why do we want Ubiquitous Computing to happen ?

- ❑ In this era of 'digital convergence', the computing technology is the glue that puts many isolated technologies together into a product (- much like the water in living tissues).



- ❑ For many information services, the computing technology functions as the medium for delivering such digitally synthesized products to the end users (- much like the canals in a wetland).



❑ Areas beyond the reach of medicines – Most medicines (s.a., antibiotics) work by dissolving into the bloodstream and reaching the tissue. Therefore, once a disease agent invades and establishes its base in a tissue which the blood hardly reaches (s.a., the nervous system), the disease becomes extremely difficult to treat even if there exist medicines which the agent must have responded very well in the bloodstream.

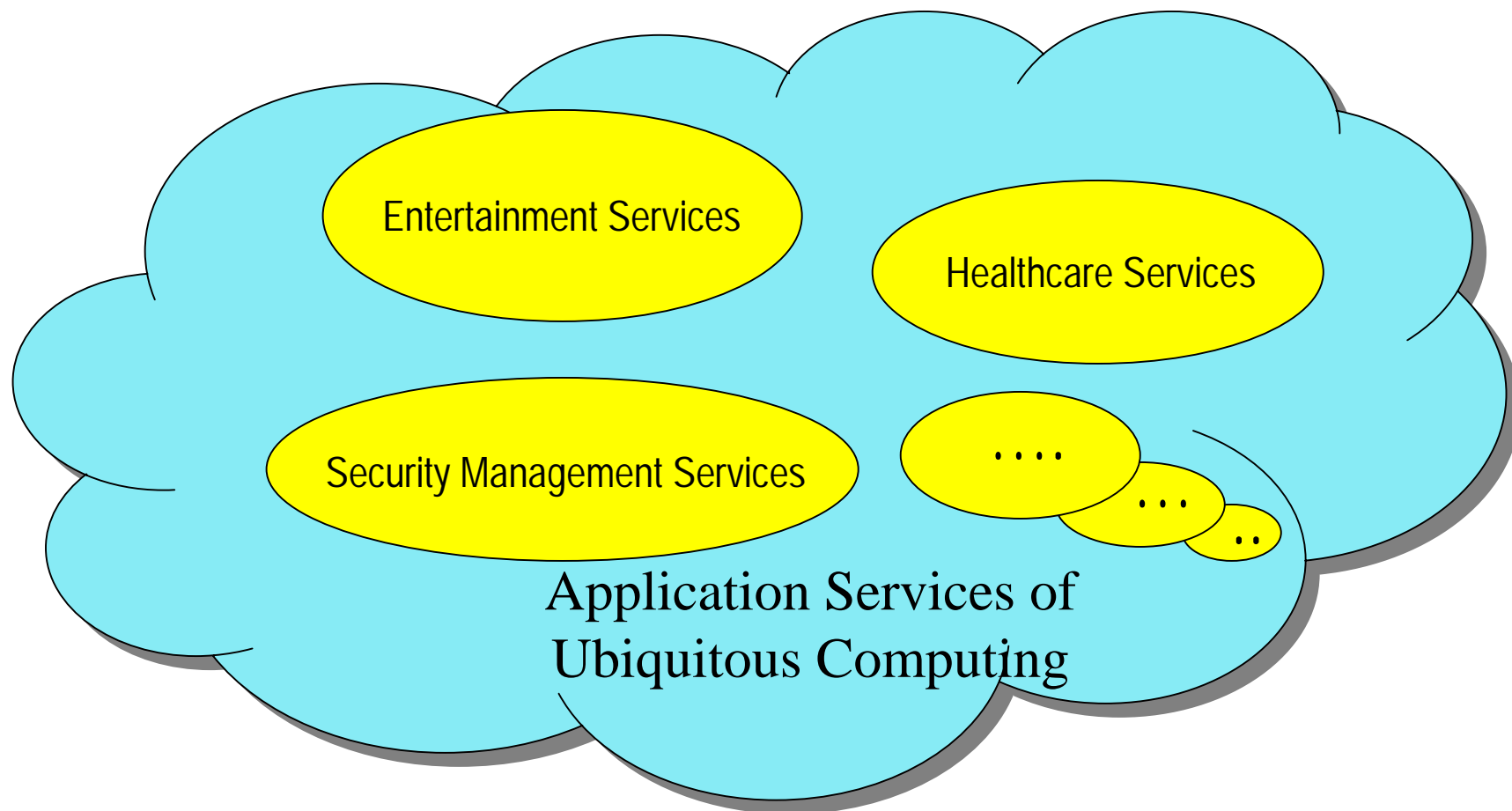
- ❑ *Areas beyond the reach of computing* – A satisfying service is not likely to be realized, if the realization of the service requires certain computing resource to be available at a certain place at a certain time, but the demanded computing resource is not available as needed.
- ❑ Ubiquitous computing is, thus, a well-motivated campaign for eliminating the spots still remaining *beyond the reach of 'computing'*; a maximum dispersion of computing is essential for a best utilization for human use of technology advancement in all facets.

How can we facilitate Ubiquitous Computing to happen ?

- ❑ UC will be facilitated when *UC-enabling technologies* advance enough so that UC will become technologically more feasible (- technology push of UC).
- ❑ UC will be facilitated as more ideas for new market-attractive *UC application services* are formed so that they will create new demands for a wider dispersion of computing (- service pull of UC).
- ❑ A new UC application service will become feasible only when the technologies enabling the service are all secured (- technology push of services).

Few critical UC-enabling Technologies

- Scalable low-end computers at economic cost
- Innovative energy supply
- Networks of versatile capabilities over various media (esp., over the air)
- Intelligent and friendly HCI
- Context-awareness (including environment sensing)
- Machine intelligence to deal with problems of extreme complexity in non-algorithmic manners
- Cyber-security
- etc.



A few examples of UC Application Services

When can we dare say that computing is ubiquitous ?

□ For all practical purposes, we can say that the computing dispersion is enough

- when we find no area left beyond the reach of computing where there is a need for it;
- when we feel no shortage of computing resources for any task that we wish to perform;
- when we no longer get concerned with the computing around us since its availability is out of question.

Services

In a Ubiquitous Computing Environment

- **Two kinds of services related to UC**
- **The basics of ‘Good’ services**
- **Key attributes of good UC application services**

Two kinds of Services related to UC

- ❑ **Ubiquitous Computing Service**: a service providing the customers with rich computing resources accessible everywhere (- analogous to the internet access service or telecom bearer service).
- ❑ **Ubiquitous Computing Application Services**: services that utilize the fundamental condition of a UC environment, the “availability of unlimited computing resources accessible everywhere”. (- analogous to many services that utilize the internet infrastructure).

The basics of 'Good' services

□ Good services valued by customers generally exhibit the following traits:

- The system collects and analyzes all the information potentially relevant to the service;
- The system computes a best proper logic to generate the service;
- The service delivered to the customer well-suits the corresponding situation;
- The system attentively listens to the customer's wishes, but does not bother the customer when he/she does not wish to be involved.

Key attributes of good UC application services

- Context-aware services
- Services with the concept of user-supremacy
- Services by omni-cognizant agent

Context-aware services

- In producing the service, the agent utilizes all relevant contextual information -- about the surrounding environment as well as the user's own personal internal (e.g., emotional) or external (e.g., situational) states.

Services with the concept of user-supremacy

- ❑ The user will never have to know anything that he/she does not have to and does not wish to know;
- ❑ The user will have to preserve a way of altering, at no pain, any part of the quality of the service when he/she wishes to have it differently;
- ❑ The user will have to receive desired services all appropriately composed in a seamless manner -- across all contextual changes over time, space, mode of activities or in any dimension that one can imagine.

Services by omni-cognizant agent

- ❑ The agent collects *all* relevant information extracted from the contexts of *all* nature: physical, environmental, mental, social, historical, etc.
- ❑ In producing the best user-customized service, the agent makes a *best* judgment possible using all pieces of information that it acquires.
- ❑ The agent delivers the service to the user in possibly the *most* friendly manner.

Overview of Typical Systems

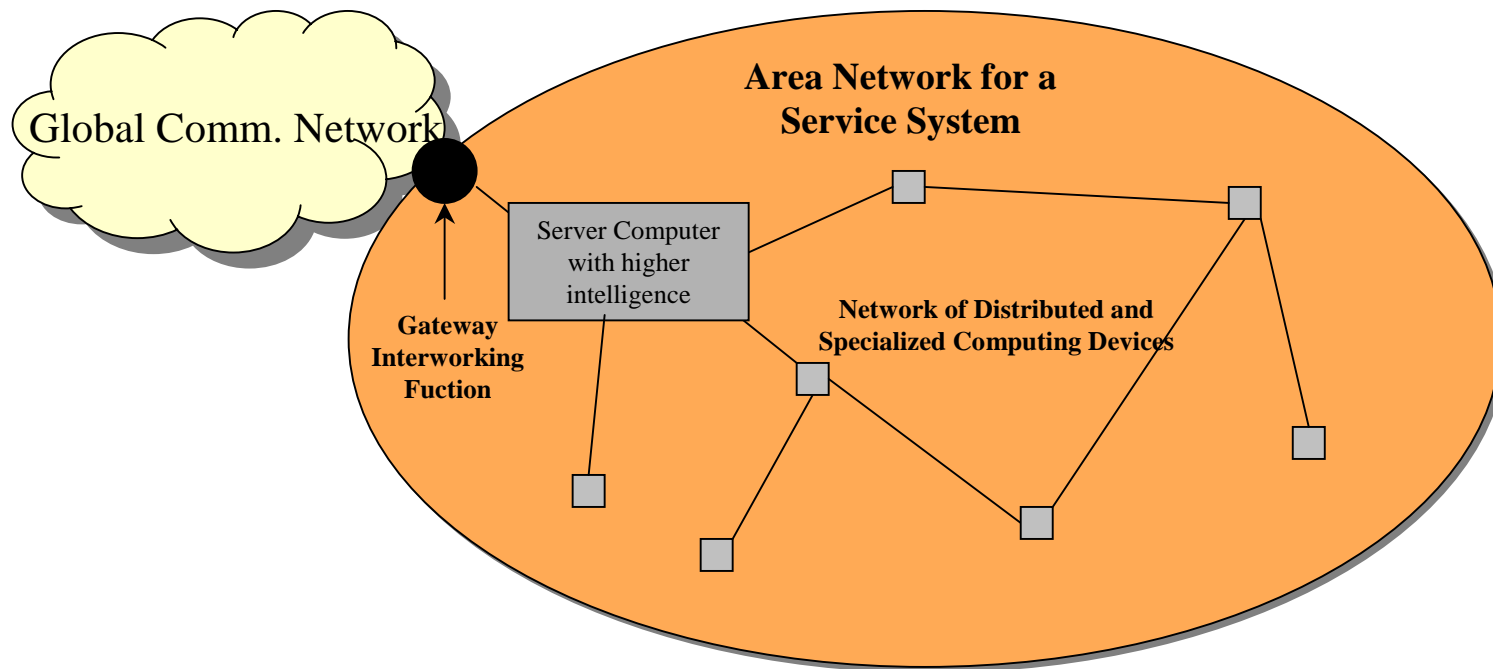
for Delivery of Ubiquitous Computing Application Services

- **Network requirements for UC application services**
- **Future Global Communications Network to support UC application services**
- **Future Communications Networks for UC application services**

Network requirements for UC application services

- ❑ A number of adequate solutions for data transfer with various capabilities, to support sensor/actuator data exchange within a service subnet in a UC environment.

- ❑ Some service agents must possess an adequate means of accessing the GCN for following purposes:
 - To acquire information from an external information bank;
 - To communicate with the remotely located user;
 - To collect sensor data from a remotely located sensor or sensor cluster;
 - To deliver actuation data to a remotely located actuator or actuator cluster;
 - Etc.



Architecture of typical systems for UC application services

Notes:

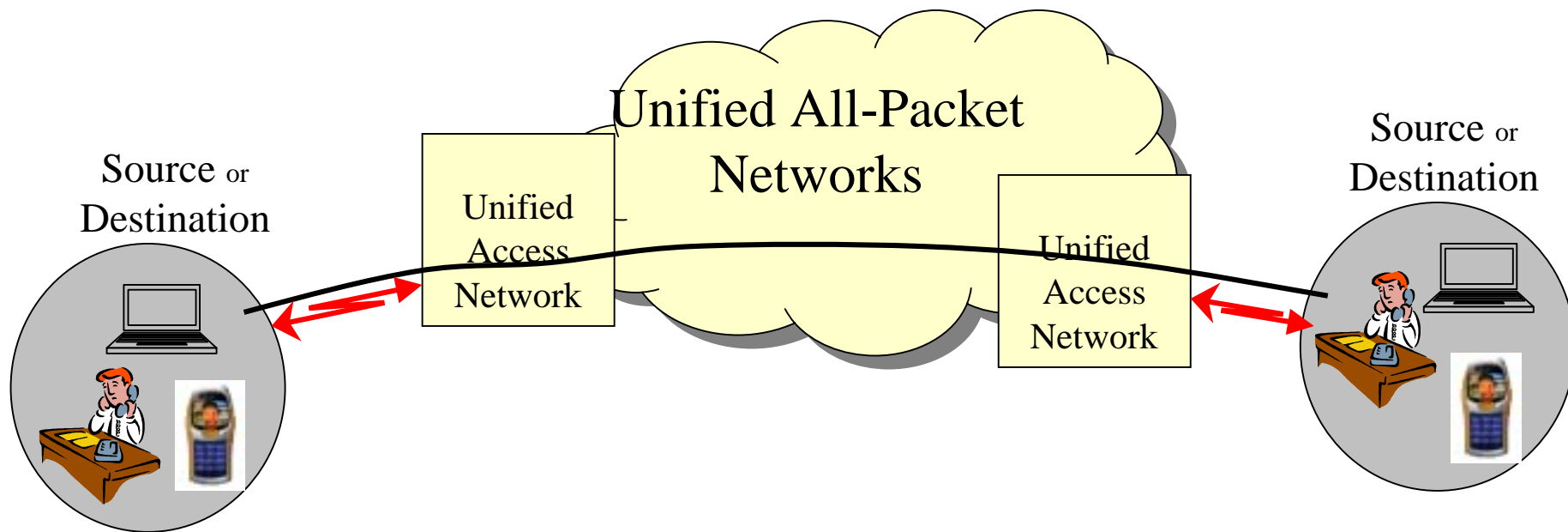
- Specialized Computing Devices sense and collect context information, actuate physical actions, or interact with the user.
- The specification of the Area Network of distributed and specialized computing devices varies, depending on the service to be delivered.

➤ Future Global Comm. Networks to support UC application services

❑ GCNs unified into one kind through a *Grand Unification* will cover the entire world.

Grand Unification

- *Access Unification*: Different access methods (including the wireless and wireline) will become interchangeable for one logical user under one account.
- *Network Unification*: Circuit and packet networks will become unified into All-Packet Network.
- User-Addressing Unification: All different methods (such as, E.164, IP, etc.) of user addressing will be unified or at least become interchangeable.



GCNs after a Grand Unification

Future Communications Networks for UC application services

- ❑ Quite a number of new radio interface technologies and network protocols will continue to be introduced, very likely to label each of themselves as a specification for a small size area network.
- ❑ Many of such small size area networks can each be used to constitute an isolated special purpose wireless network (e.g., for a sensor network, home network, etc.).

- ❑ Some well-defined small size area networks can each successfully obtain the status of being complementary to the GCNs.
- ❑ An area network is interfaced with a GCN at a gateway box which will provide the two networks with a necessary interworking function.
- ❑ Isolated or not, many area networks for UC application services can take the advantage of small size wireless area networks to interconnect their own component devices.

Wireless Communications

for Ubiquitous Computing

- **Wireless Access to Global Communications Network**
- **Wireless Communications within an Area Network for UC**

Wireless Access to Global Communications Network

- ❑ A number of radio access standards (e.g., WCDMA, CDMA-2000, GPRS, GSM, 802.11-series, etc.) will provide alternative wireless accesses to the grand unified GCN, while various types of wireline accesses will still remain as primary accesses of GCN.
- ❑ Without an adequate means of radio access to the GCN made available, a UC environment may not be constituted or many UC application services will not be realized.

Wireless Communications within an Area Network for UC

- ❑ A number of wireless access standards or industry practices (e.g., Bluetooth, 802.11-series, UWB, etc.) will provide alternative wireless accesses within an area network.
- ❑ Without an adequate means of wireless access within the area network, a UC environment may not be constituted or many UC application services will not be realized.

Epilogue

In many cases of sophisticated service realizations in the future, making wired connections between many computing devices would simply be impossible due to reasons such as user's mobility, dynamic changes of connection configurations, etc. Without wireless communications, effective dispersion of computing would become practically impossible, thereby leading to a failure in building a ubiquitous computing environment.

On this ground, we conclude that wireless communication is an essential enabling building block for future ubiquitous computing. We urge the communications industry to secure workable wireless solutions to successfully encompass all key scenarios of wireless situations, so that our march to the "Brave New Convergence" can continue.

Thank You