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The Next Generation Network Suitable for Intelligent Transportation System

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- Some Problems with GPS-based ITS
- SS-NGN-based Approach
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What is ITS?

- The term **Intelligent Transportation System** (**ITS**) refers to efforts to add information and communications technology (**ICT**) to transport infrastructure and vehicles in an effort to **manage factors** that typically are at odds with each other, such as vehicles, loads, and routes to **improve** safety and **reduce** vehicle wear, transportation times, and **fuel consumption**.

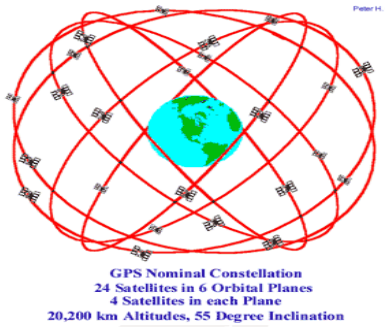
  http://en.wikipedia.org/wiki/Intelligent_transportation_system

Can ICT do it?

- Can the existing ITC fulfill the duty?
- It is **very difficult** for the **existing ITC** to fulfill the duty!
- The reason is the existing computer network (Internet) is independent of physical world.
  - Can not support physical temporal operation
  - Can not support physical spatial operation

Vehicle Locating and Navigating

- One of important applications of ITS is vehicle locating and navigating.
- Intelligent vehicle navigating can **relieve** the **traffic jam** in our city.
- But it is not a reality!
- The **existing approach** of vehicle locating and navigating is almost depend on the **GPS** and **static digital map**.



What is GPS?

- The **Global Positioning System** (**GPS**) is a space-based global navigation satellite system(**GNSS**) that provides reliable location and time information in all weather and at all times and anywhere **on or near the Earth** where there is an **unobstructed line of sight** to **four or more** GPS satellites.

http://en.wikipedia.org/wiki/Global_Positioning_System

Is GPS-based Navigation Good for ITS?

- There are some **shortages** of using GPS in cities' environment
  - Buildings can **obstruct** and **reflect** the satellite signals
  - It is **difficult** to **integrate** the GPS with Road information system.
- It is very **expansive** to establish the GPS for vehicle navigation in cities
  - Establish satellite constellation **in the space**
  - Establish augmentation system on the **ground**

How to Establish ITS in an Economical way?

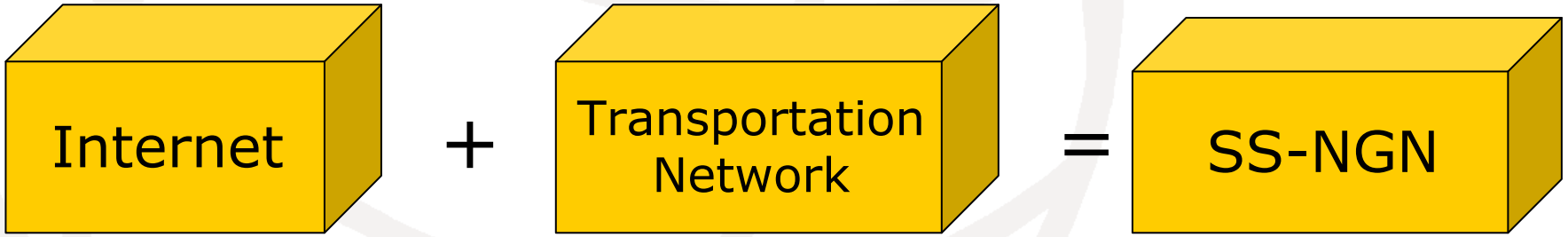
- GPS-based vehicle navigation in city is not an economical approach
- GPS-based ITS in the city is not an economical approach
- How to Establish ITS in **an Economical way**?
- One approach is to increase the capabilities of ICT to make available the vehicle navigation on the ground network.

Our Proposal

- Our proposal: Using **spatial semantics-enabled** next generation network (**NGN**) to **integrate** the functions of **road monitoring**, **vehicle locating**, tracking, and navigating to **provide traffic-aware** navigation for the vehicles in city.
- This **NGN** is called Spatial Semantic-enabled Next Generation Network, that is, **SS-NGN**.

The Features of SS-NGN

- The deepest rooted feature of SS-NGN is the **convergence** of the computer network with the transportation network
- SS-NGN is typically one of the **Internet of Things**.

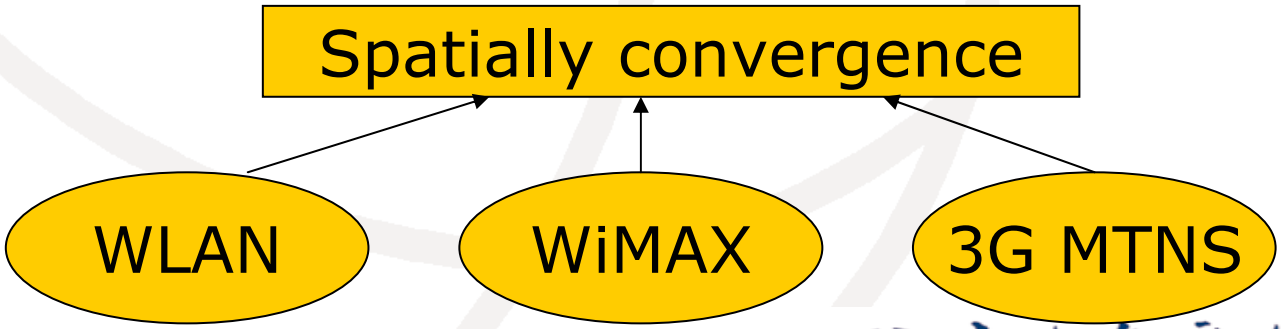


The Characteristics of SS-NGN (1)

- In the view of computer network, SS-NGN has the following characteristics:

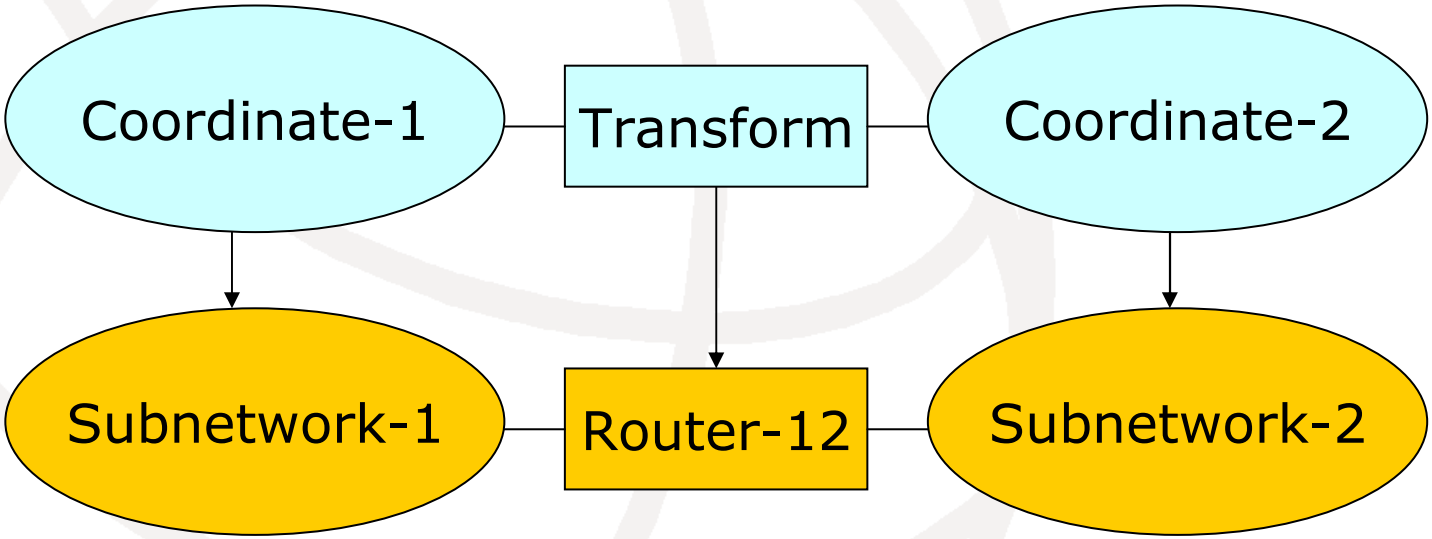
(1) **Spatially convergence** of different **transmission networks**,

- such as different wireless networks, i.e., WLAN, WiMAX, 3G



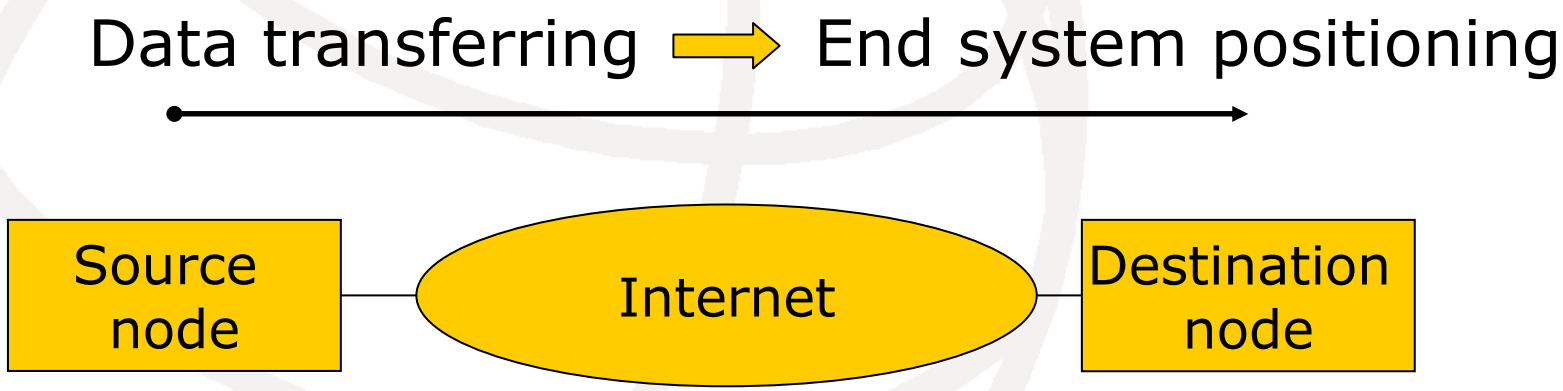
The Characteristics of SS-NGN (2)

(2) Combination of **network interconnection** with **spatial coordinate** transformation.



The Characteristics of SS-NGN (3)

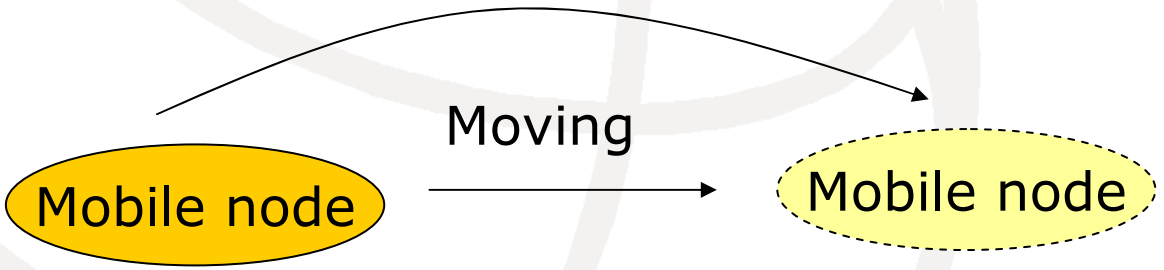
- Integration of **end-to-end data transferring** with end system **positioning**, which can be used for vehicle positioning.



The Characteristics of SS-NGN (4)

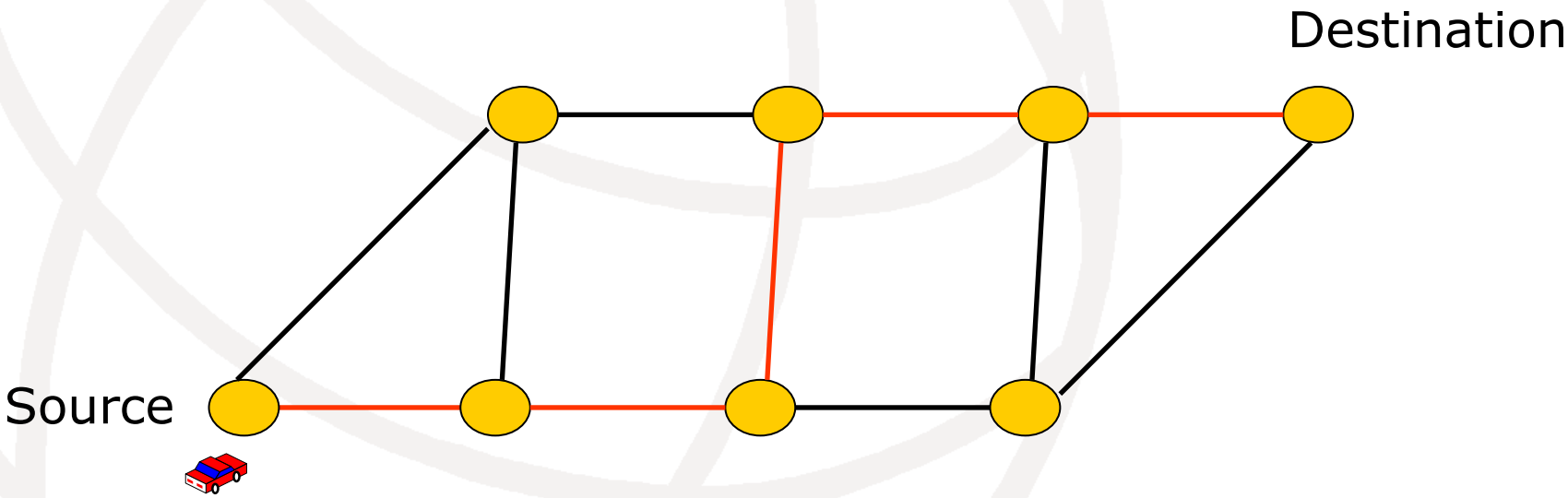
- **Management of mobile node** with **spatial location** information, which can be used for vehicle tracking.

SS-NGN: Tracking the mobile node



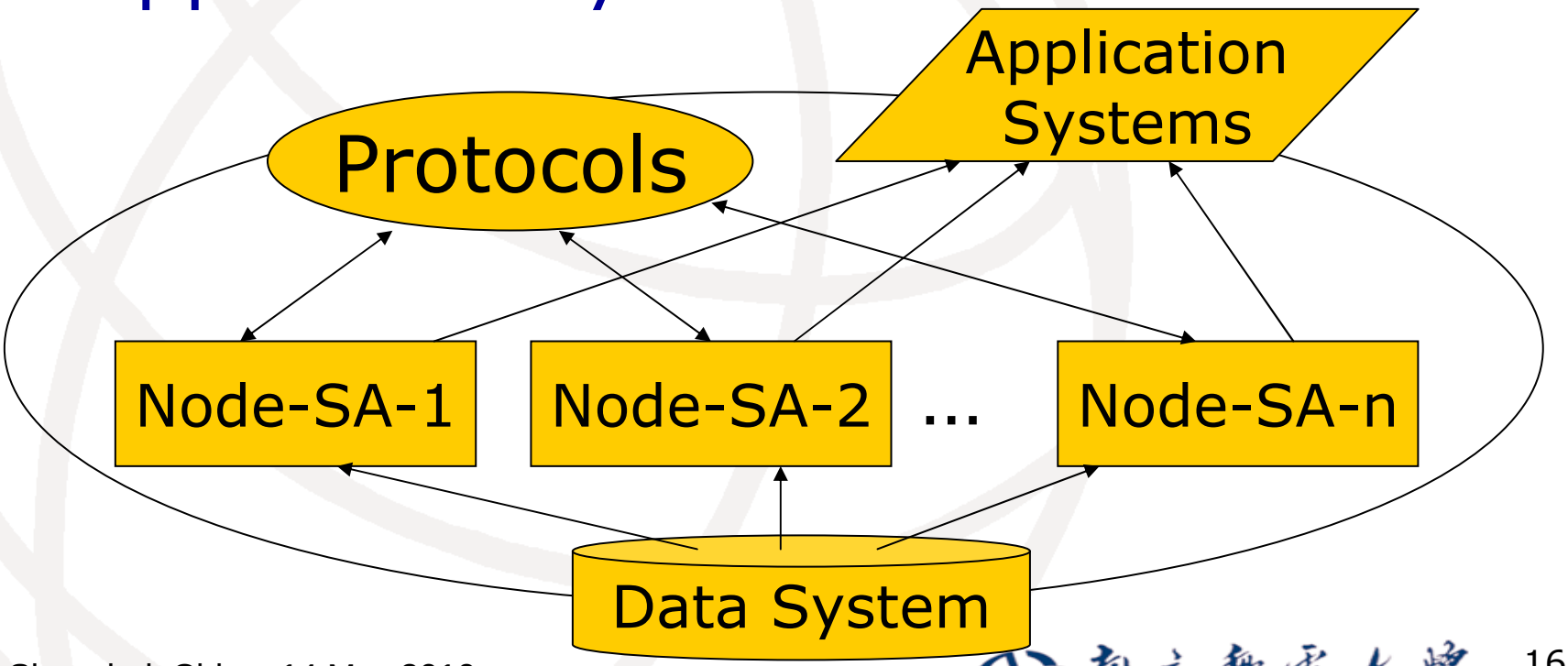
The Characteristics of SS-NGN (5)

- Selection of path with spatial location information, which can be used for vehicle navigation.



Architecture of SS-NGN

- SS-NGN consists of network node with spatial attributes, coordinates, protocols, data system, and application system.

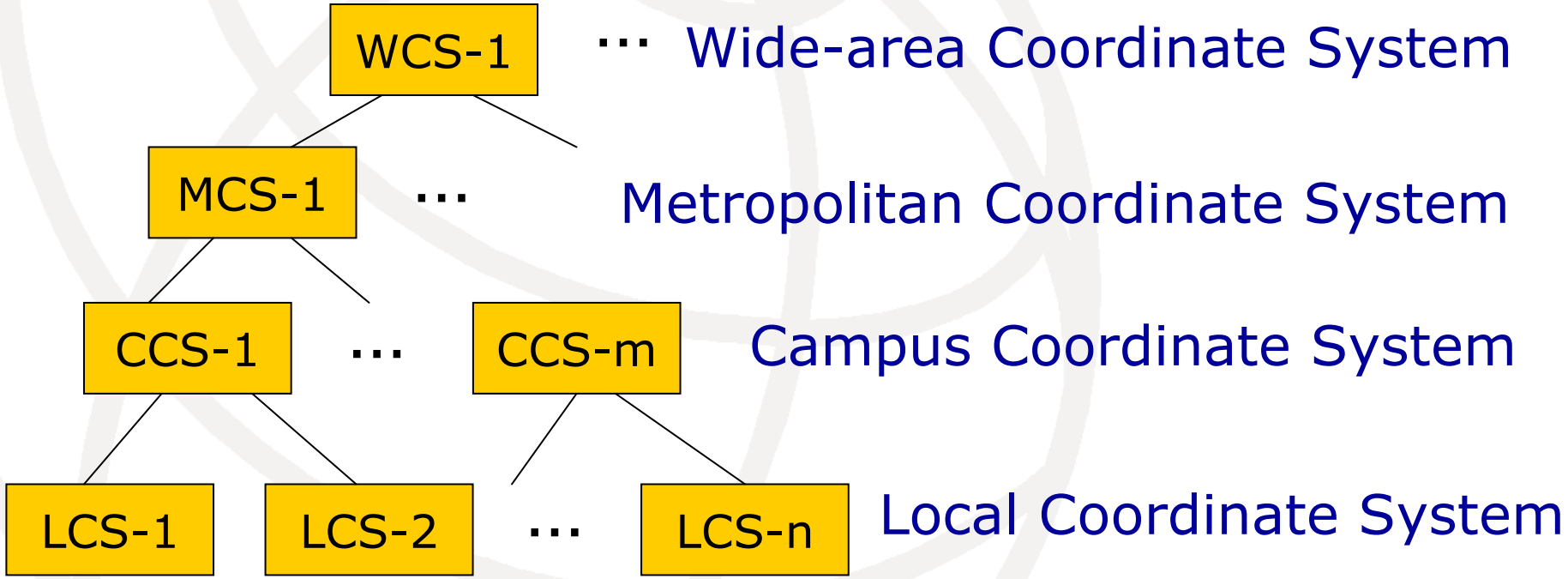


Network node with spatial attribute

- Every node in SS-NGN is assigned spatial attribute, which can identify the position of this node in the physical world.
- The spatial attribute includes the **X and Y coordinates** on the digital map of some city.

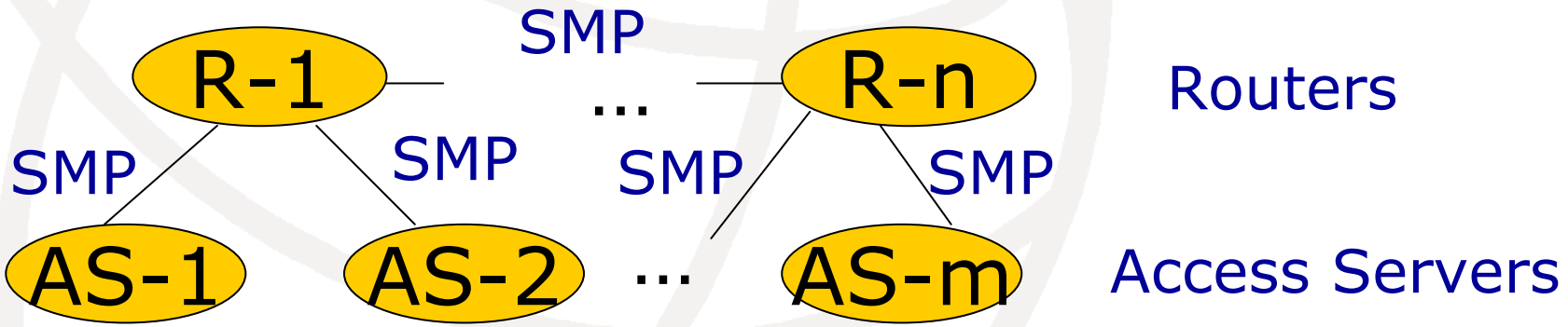
Spatial Coordinate System

- **Hierarchical structure** of spatial coordinate system **corresponding with** the **Internet**



Spatial Management Protocol

- **Core network nodes**, such as **router**, **access server**, are connected by spatial management protocol (**SMP**).
- **SMP** is used to **establish**, **interconnect** and **maintain** the spatial coordinate systems in SS-NGN.



Spatial Access Protocol

- The end system node (moving car) can be connected with the SS-NGN through **spatial access protocol** (SAP).
- SAP can identify the spatial coordinate system, assign and update the coordinate value of node.

Spatial Data System

- **Spatial data system** (SDS) is used to **store** the node identifier, coordinate values, geometry information of node sets, and name of these node sets.
- **Network node sets** of SS-NGN can be used to identify the things in ITS, such as road, building, park, hotel.

Spatial Application System

- SS-NGN has some **internal** spatial application systems (**SAS**) which can be used as **middleware** to facilitate the construction of intelligent transportation system.
- The **SAS** defined in SS-NGN includes Cyber Spatial Positioning (**CSP**), Cyber Spatial Tracking (**CST**) and Cyber Spatial Navigating (**CSN**).

The Necessity for Standardization

- **SS-NGN** is one type of **NGN**, it is based on existing Internet.
- Internet's power and application values are in its interconnectivity and scalability.
- In order to make the SS-NGN practical available, it should be standardized.

What is NGN

- The **Next generation networking** (**NGN**) is a broad term to describe some key architectural evolutions in telecommunication core and access networks that will be deployed over the next 5–10 years. The **general idea** behind NGN is that **one network transports** all information and services (voice, data, and all sorts of media such as video) by encapsulating these into packets, like it is on the **Internet**. NGNs are commonly built around the Internet Protocol, and therefore the term "**all-IP**" is also sometimes used to describe the transformation toward NGN.

  http://en.wikipedia.org/wiki/Next_generation_networking

Some Standardization Issues (1)

- The following aspects of SS-NGN should be standardized:

(1) the **architecture** of SS-NGN, such as, components of SS-NGN, and the interfaces between these components;

(2)the spatial coordinate systems of SS-NGN, such as, LCS, MCS, WCS;

Some Standardization Issues (2)

(3) the **protocols** of SS-NGN, such as, spatial access protocol and spatial management protocol;

(4) the **data system** of SS-NGN, this is DNS-like system in the SS-NGN;

(5) the **application systems** of SS-NGN, such as, Cyber Spatial Positioning (CSP), Cyber Spatial Tracking (CST) and Cyber Spatial Navigating (CSN).

Conclusion

- The ITS is very **promising** system, which will be built into the **information infrastructure** of our society.
- For it is very **complex** to design and implement ITS, it is worthwhile to **invent** some theories and technologies to cope with the ITS problems.
- SS-NGN **expands** the NGN with **spatial semantics**. More research works need to be done on it.