

- **IEEE 802.21 MEDIA INDEPENDENT HANDOVER**
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- **Title: A proposal for MIH function and Information Service**
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- Abstract: This document provides a partial proposal according to 802.21 requirements document and it covers two important functions namely, MIH function and Information Service. It also describes how this can be applied in specific handover scenarios.

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Proposal Scope

- Covers three important functions
 - MIH function
 - Information Service
 - Event Triggers
- Describes specific handover scenarios and call flow
 - Intra-technology
 - Inter-technology



Proposal Outline

- MIH function
 - MIH functions and its model
 - Secure handover
- Information Service
 - Discovery, detection and selection
 - Information that the device needs for handover optimization
 - Information service model
- Event Triggers
 - Local triggers/functions
 - remote triggers/functions
- Handover Scenarios and Call Flow



Assumptions and Scenarios

- Assumptions
 - Multiple radio interfaces for heterogeneous networks
 - Single or multi(11a/b/g) interface for homogeneous networks
- Scenarios addressed
 - 802.11 to/from cellular
 - 802.11 to/from 802.11

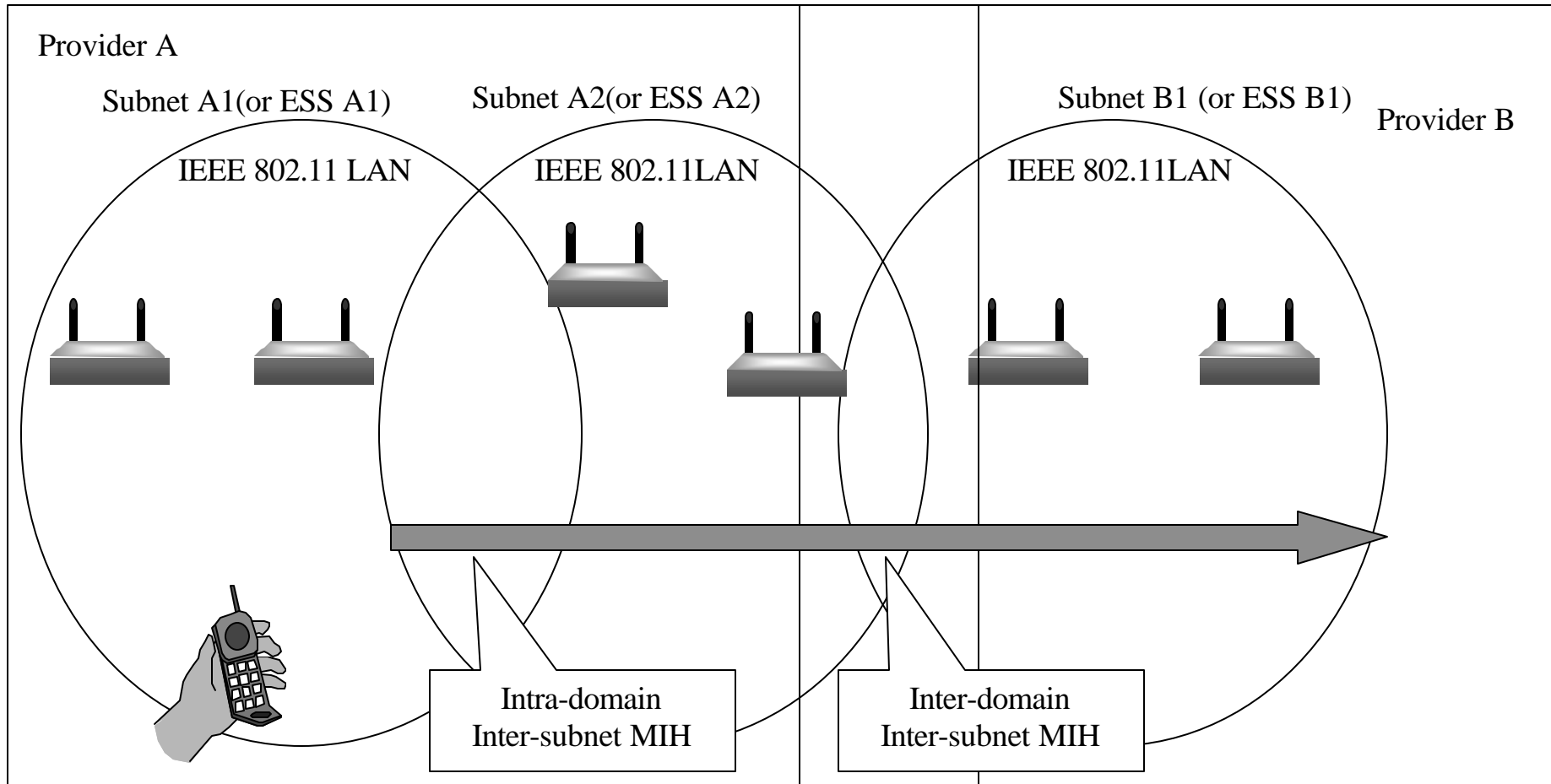


Single Radio Interface Scenario

- A mobile node with a single IEEE 802.xx interface may roam among multiple subnets and multiple administrative domains
 - MIH based on information obtained via L2 only has limitations
 - MIH might need information from higher layers
 - Efficient inter-subnet and inter-domain handoff possible



Single Radio Interface Roaming Scenario

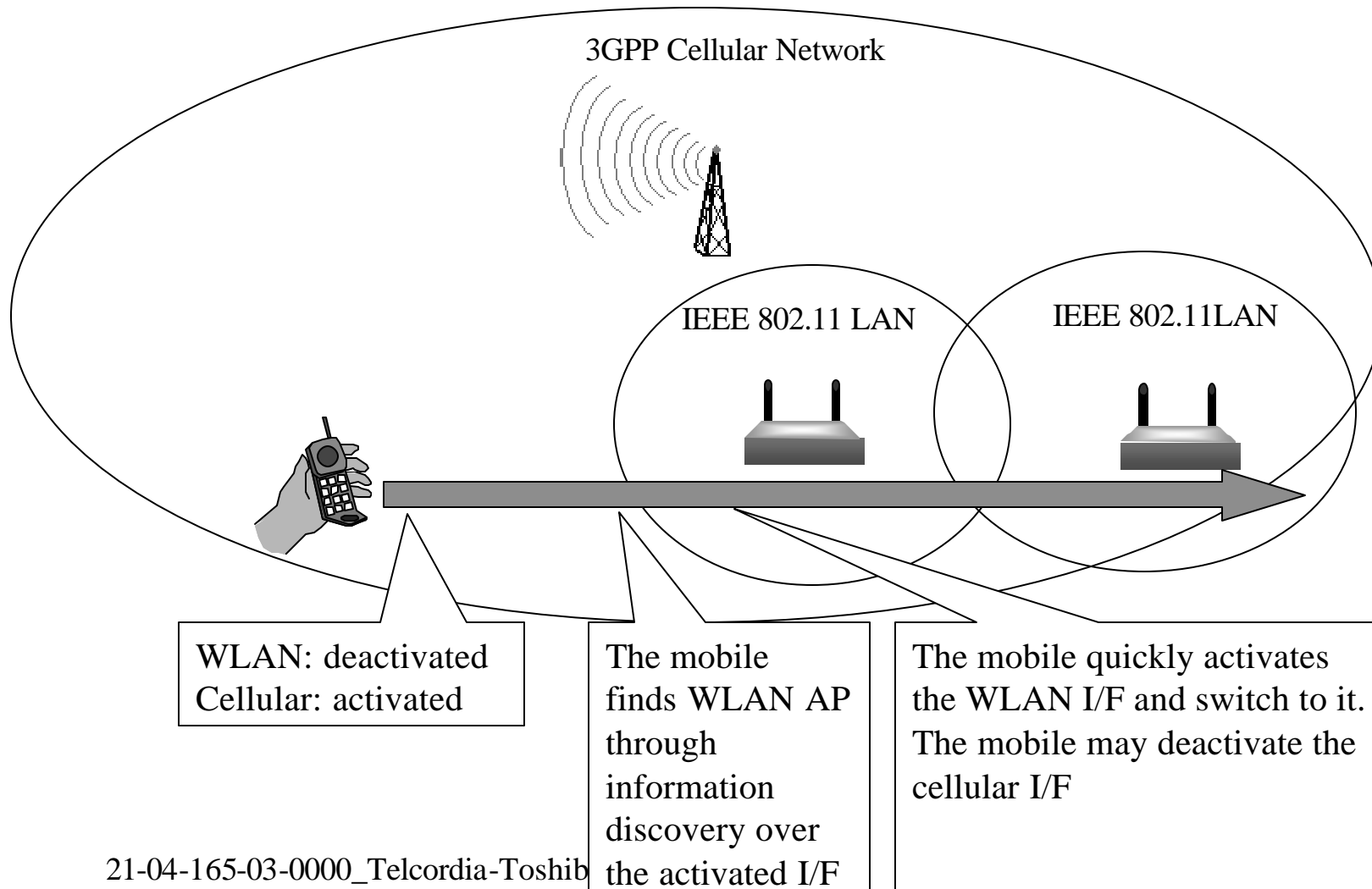




Multiple Radio Interface Scenario

- While keeping multiple interfaces always-on is an option, a mobile node may want to deactivate unused interfaces
 - Power saving is a necessary condition for small handheld devices
- Multiple networks may not have coverage always in all areas
 - In some cases one network may only be available although both interfaces are always-on
- As the mobile node moves, a deactivated interface may need to be activated depending on the radio conditions
 - Deactivated interfaces themselves cannot discover their access points/base stations
 - Information service that depends only on deactivated interface has some limitations
- MIH may further consider deactivated interfaces as candidates to switch from the currently activated interface
 - Fast interface activation may become a requirement for MIH

Multiple Radio Interface Roaming Scenario





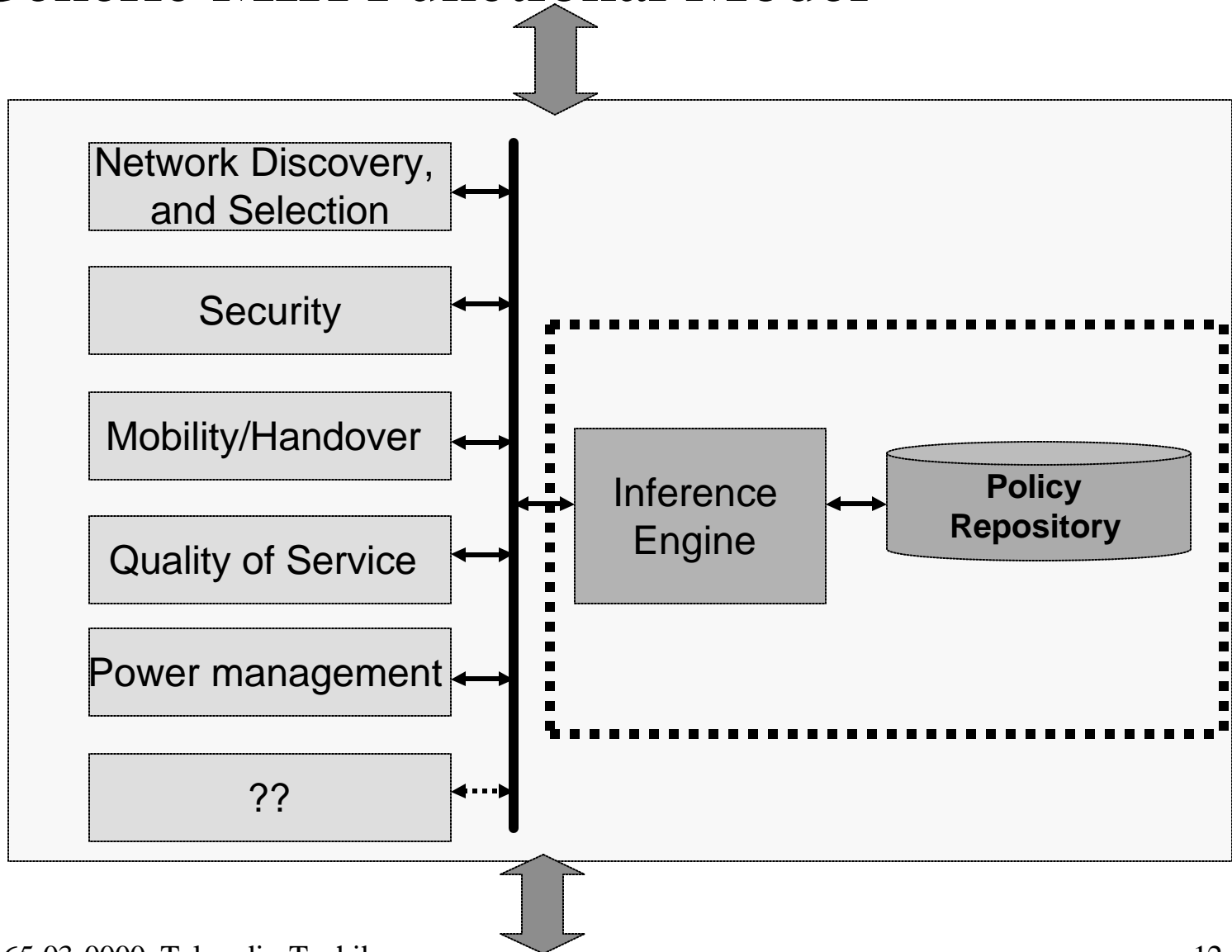
MIH function



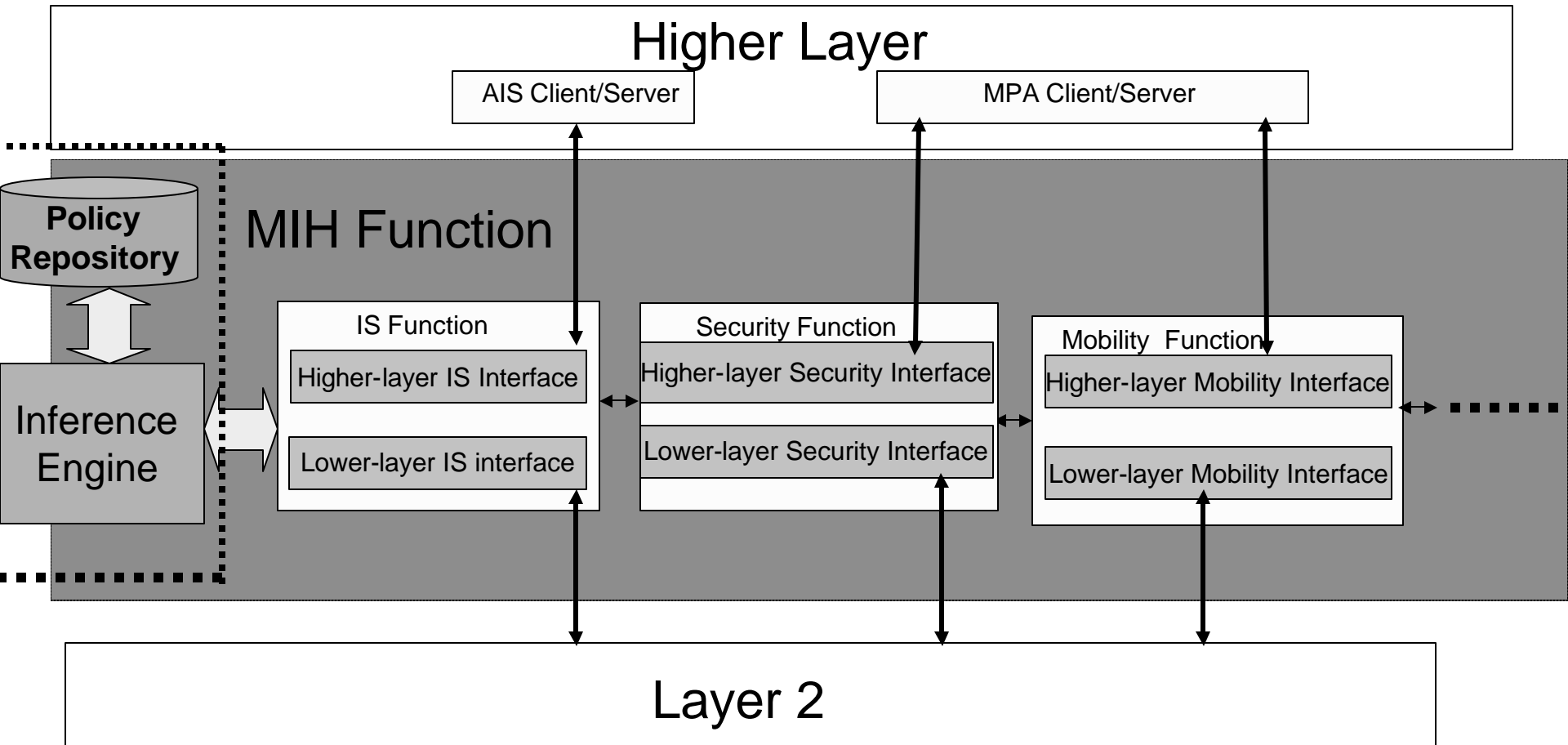
MIH Functional Components

- **Network Discovery**
- **Security**
- **Mobility/Handover**
- **Quality of Service**
- **Power Management**
- **Other**

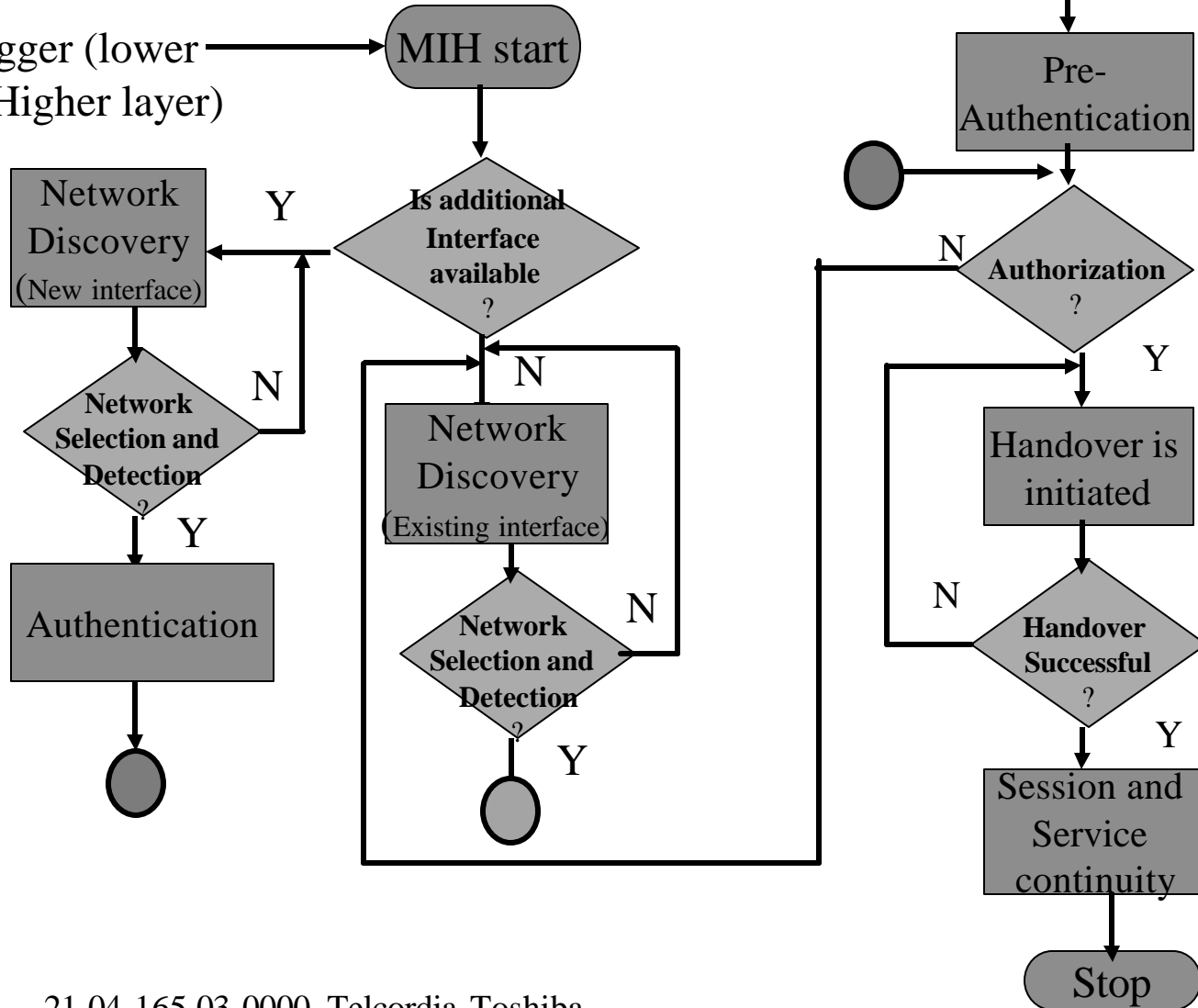
Generic MIH Functional Model



MIH Functional Model (Information Service, Mobility and Security)



Trigger (lower or Higher layer)



Secure and Seamless Handover Solution

- The solution is based upon the concept of Pre-Authentication (PA) and is defined as
 - Mobile-assisted higher-layer authentication, authorization and handover scheme that is performed a-priori to establishing L2 connectivity to a network where mobile may move in near future.
- MIH function performs this process on behalf of mobile users



MIH Pre-Authentication (MPA)

- MIH Pre-Authentication
 - Provides a secure and seamless mobility optimization that works for
 - Inter-subnet handoff
 - Inter-domain handoff
 - Inter-technology handoff
 - Use of multiple interfaces
 - Defines a new mechanism at higher layer (e.g. Network or higher layer)
 - Supports IP address change (unlike L2 pre-authentication where MAC address does not change).

Functional Components of MPA

1) Pre-authentication

- Used for establishing a security association (SA) between the mobile and a network to which the mobile **may** move
- L2 pre-authentication can also be enabled based on the established SA

2) Pre-authorization

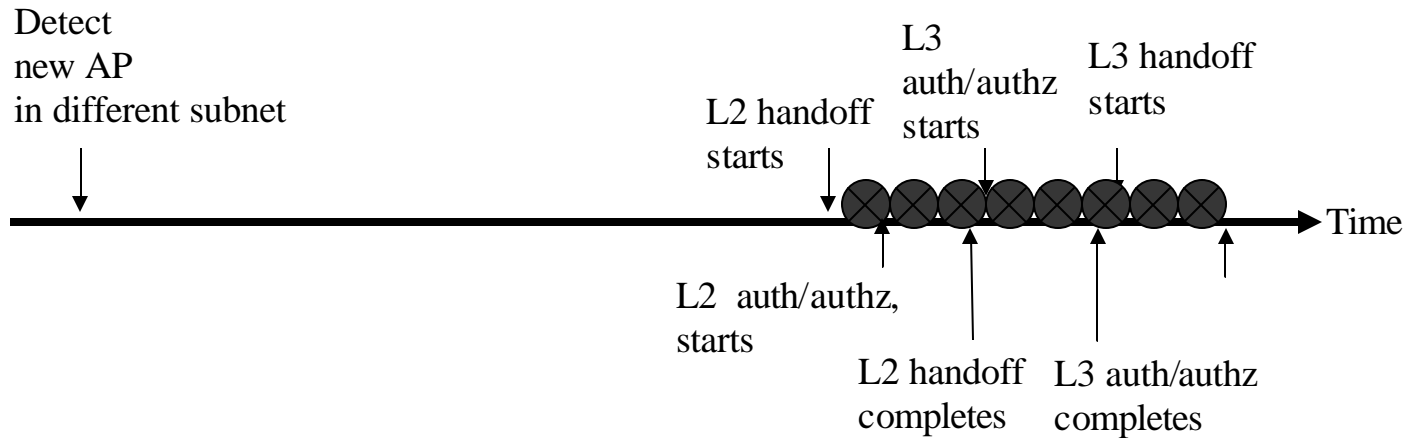
- Used for establishing contexts specific to the network to which the mobile **may** move
- The SA created in (1) are used to secure the authorization procedure

3) Proactive Handoff (PH)

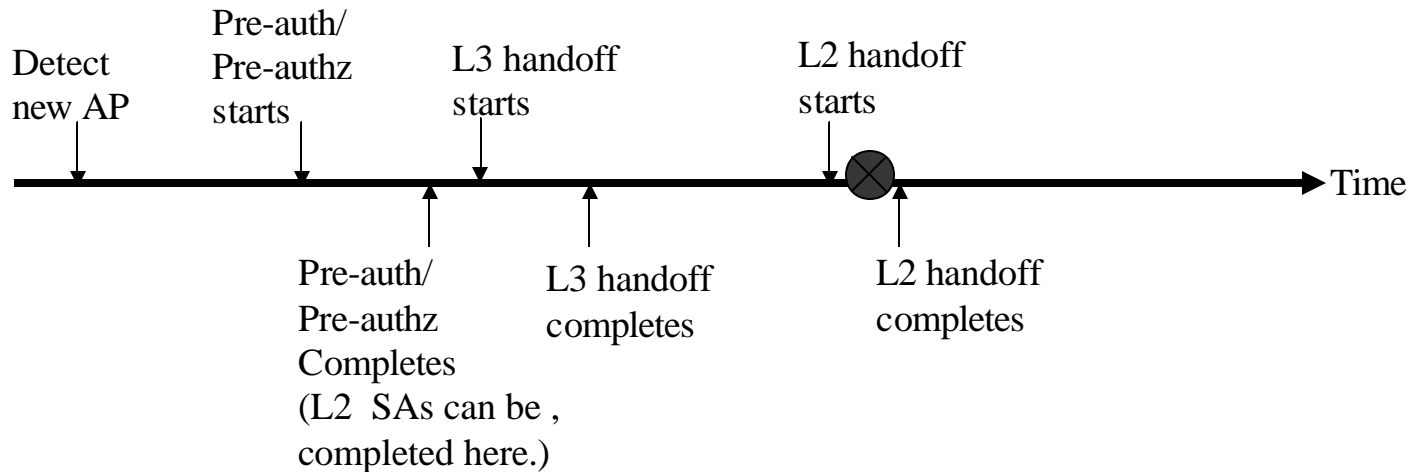
- Used for sending/receiving IP packets based on the pre-authorized contexts by using the contexts of the current network

Expected Result

Conventional Method



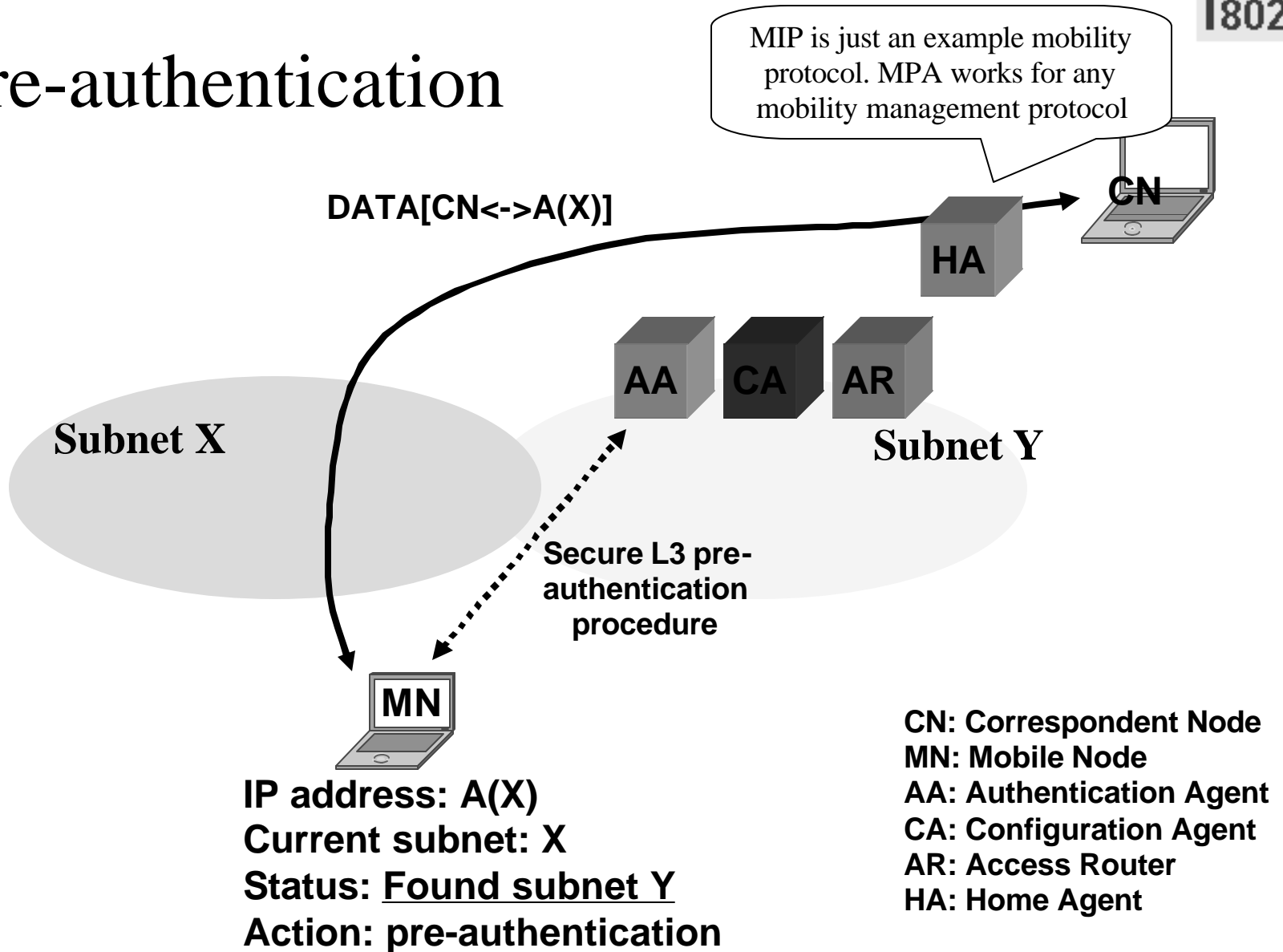
Proposed Method



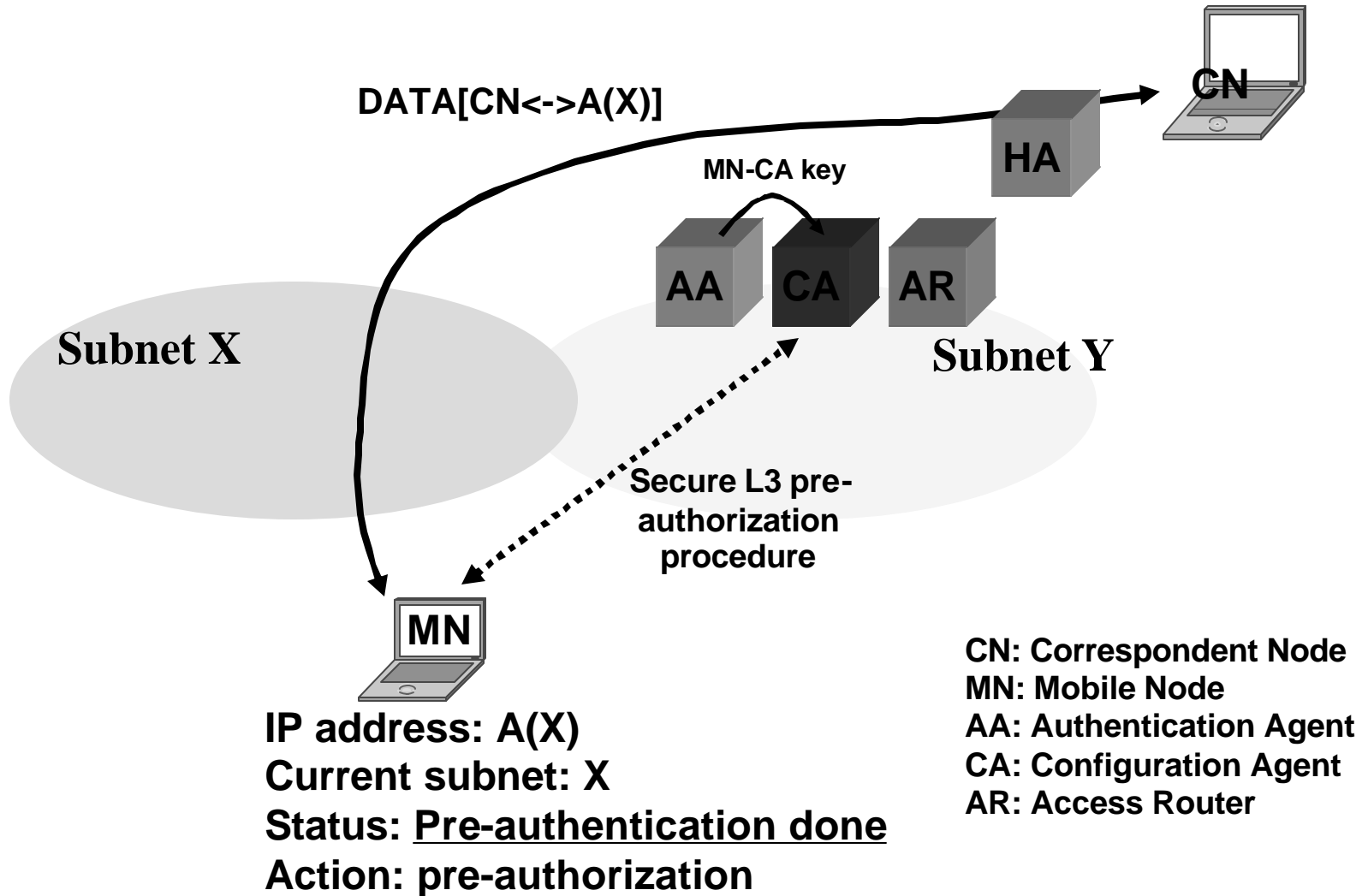
⊗ Critical period (communication interruption can occur)



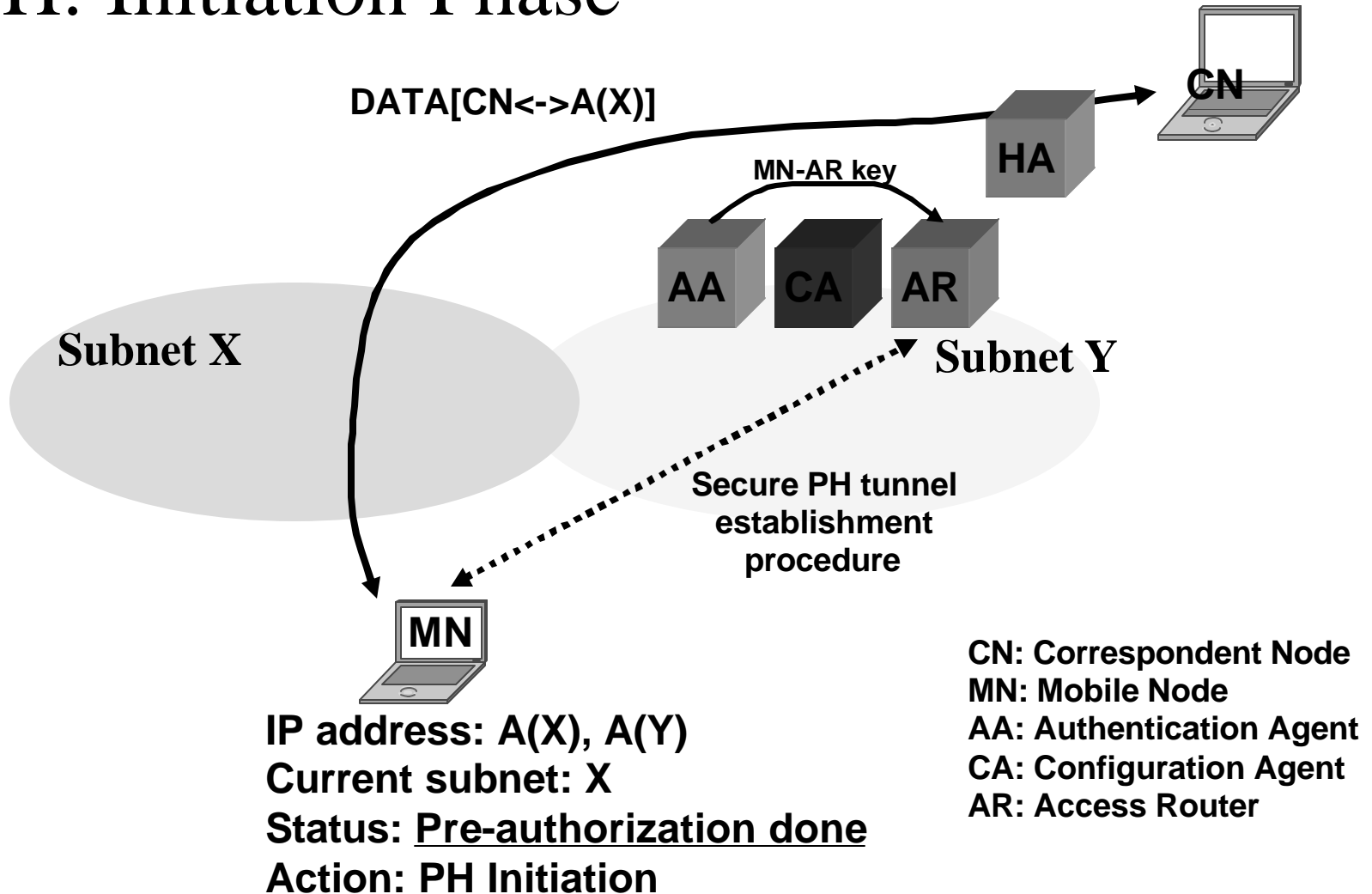
Pre-authentication



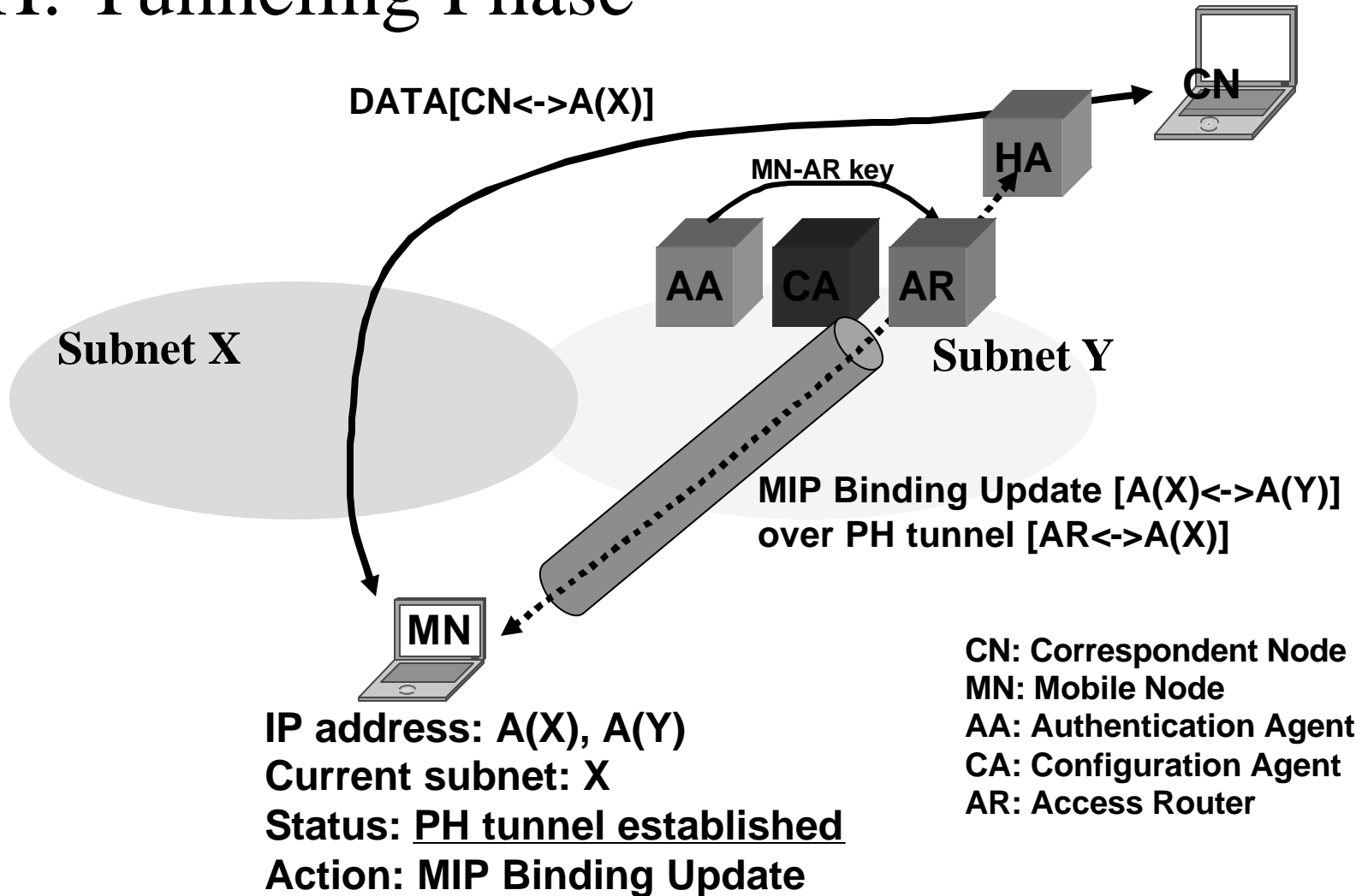
Pre-authorization



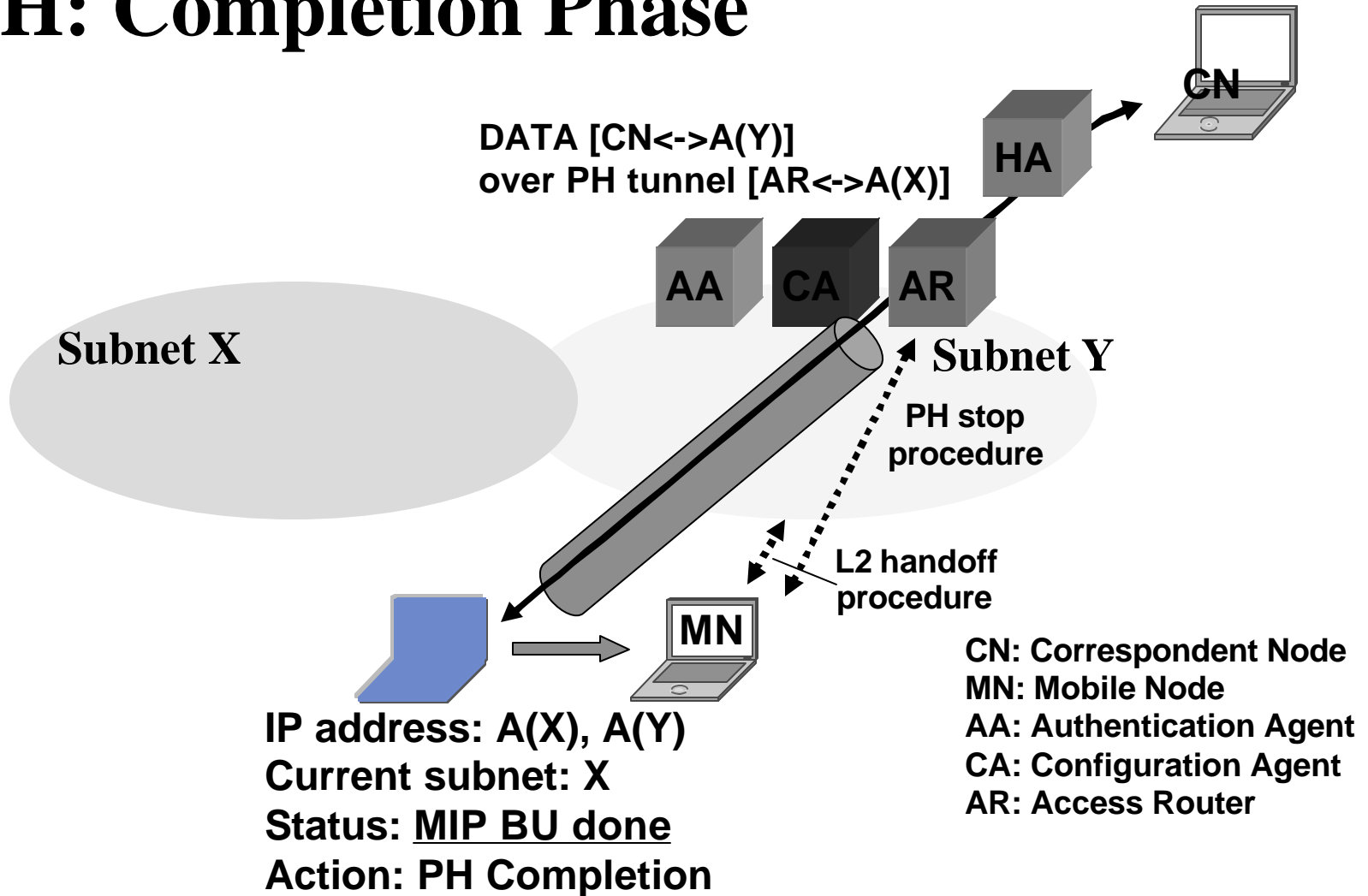
PH: Initiation Phase



PH: Tunneling Phase



PH: Completion Phase





Information Service

What is Information Service?

- Information service has the following functions
 - Network Discovery
 - Process by which device collects the information about the network(s)
 - Network Detection
 - Process by which device attaches (passive/active) the network and collect the information
 - Network Selection
 - Process by which device selects appropriate network (from the information collected by discovery and detection)

Information Service Solution

- Application-layer mechanisms for Information Service (AIS)
 - Network discovery is facilitated using XML-based technologies
 - Flexible way of retrieving L2 and L3 topological information

Application-layer mechanisms for Information Service (AIS)

- **An application-layer protocol that helps provide information about the networking elements of the neighboring networks**
- The information can consist of parameters about networking elements of various layers, e.g.,
 - access point's MAC address, access router's IP address, security model, QoS
- The information can be queried using location information as a look-up key
 - Location information can be access point identifier, geographical address, civic address, etc.
- The information will augment MIH Pre-Authentication (MPA)
- Provides a link-layer agnostic solution

AIS (cont'd)

- Provides the ability to move between the administrative domains
- Provides a framework that uses the existing standards for access point and routers without making any changes
- Provides a modular and flexible database using XML, RDF, SOAP
 - RDF database can be constructed in a distributed fashion to scale to large number of networks
 - RDF can handle arbitrary interconnected data structure while LDAP handles tree-based data structure only
 - RDF provides querying schema as well as data themselves
 - Network information can frequently change its data structure as networking technologies evolve
- Two basic approaches for construction of information service database:
 - Network-assisted database construction model
 - Mobile-assisted database construction model

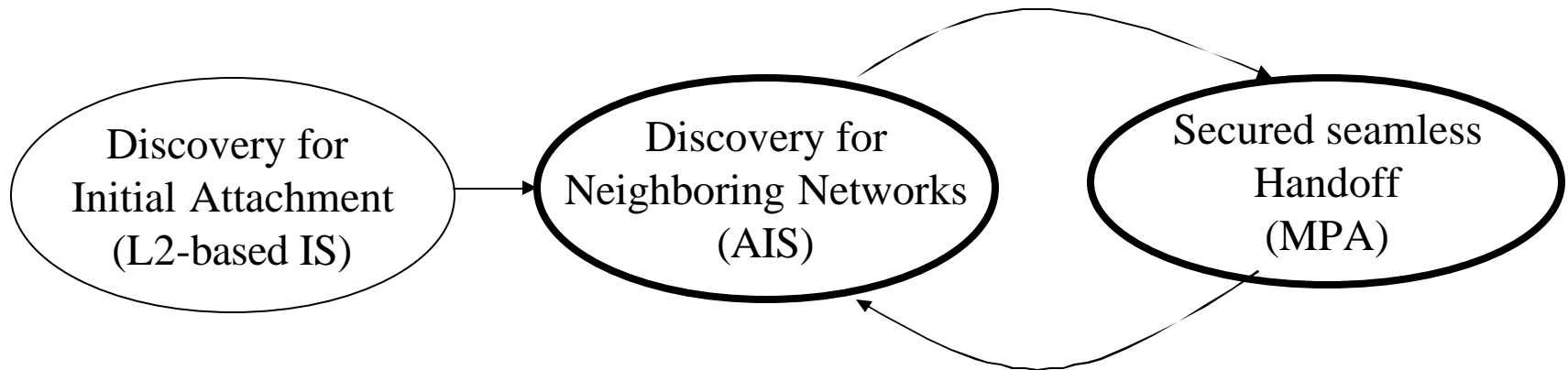


AIS Comparison with L2 Information Service

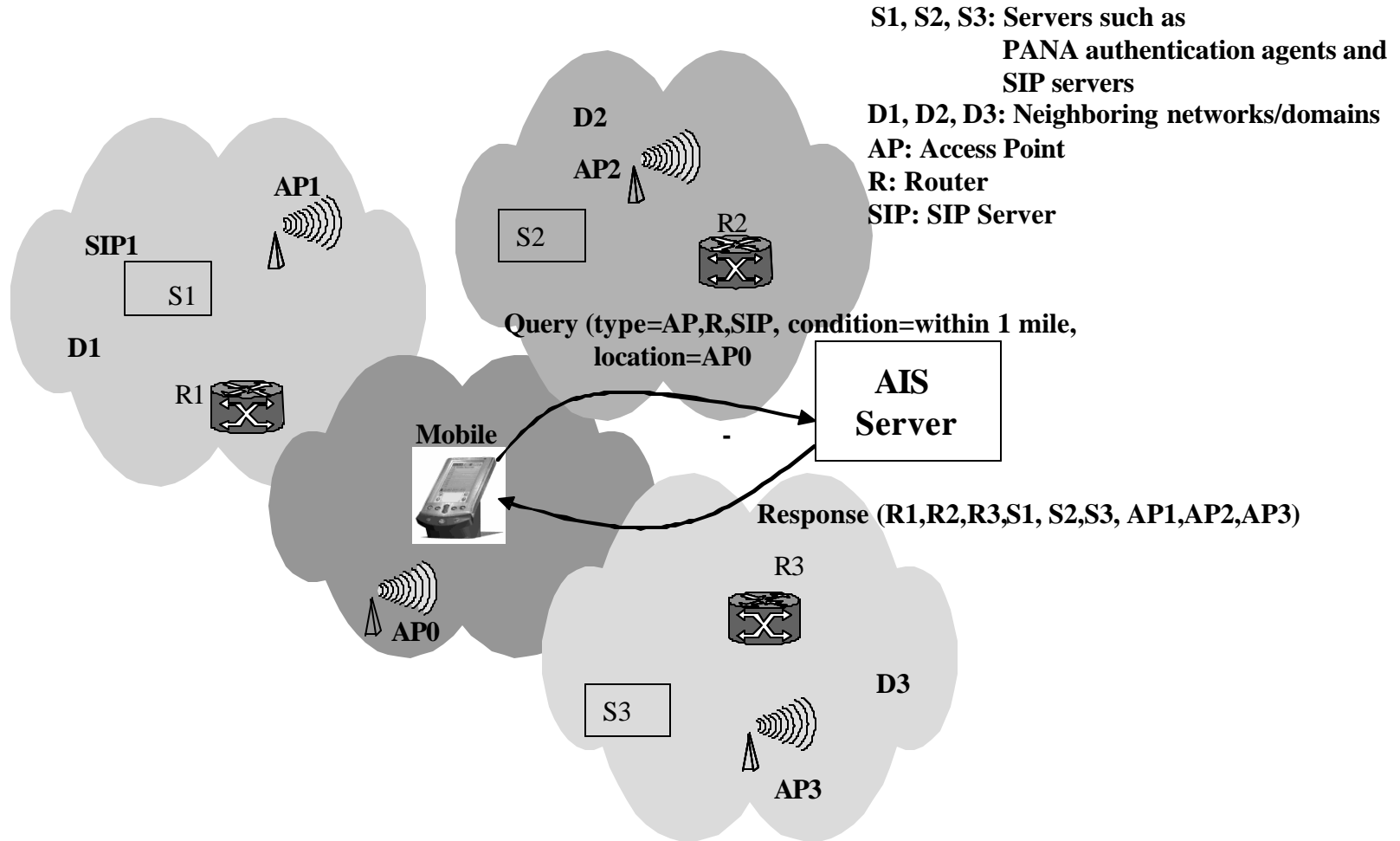
- Information service at L2 is needed for initial network attachment where no IP connectivity is available at the beginning
- Information service at L2 has some limitations
 - If information is broadcast in beacons, it consumes a lot of bandwidth
 - For example, with a Beacon interval of 100ms, and 10 APs in the vicinity, approximately 32 % of an 802.11b AP's capacity is used for
 - The mobile needs to be in radio coverage of APs that provide information service
 - A mobile moving at a high velocity may need the information before entering the radio coverage of the network
 - A multi-interface mobile may want to discover APs for a deactivated interface through the active interface
 - Difficult to handle large-sized data due to lack of fragmentation in some link-2 protocols (e.g., 802.3)
- AIS can overcome such limitations

AIS-aided Secured Seamless Handoff

- Secured seamless handoff with MPA is based on the information retrieved from the neighboring networking elements such as
 - routers, SIP servers, PANA authentication agents, etc.



Information Query Example

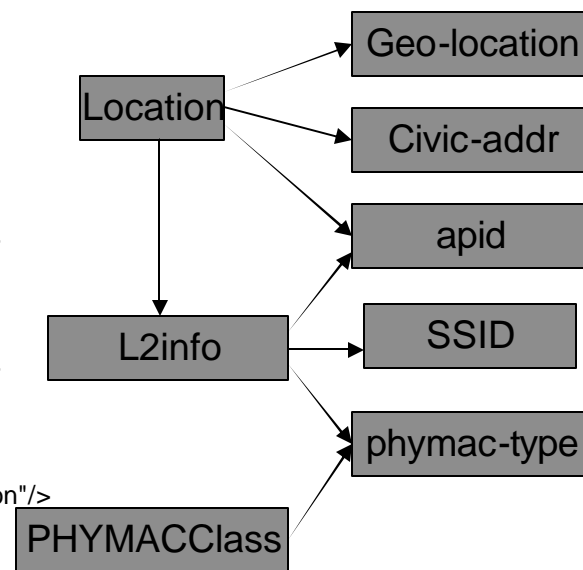


RDF Schema for AIS (partial view)

```

<rdf:RDF xml:lang="en"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:nd="http://www.networkdiscovery.org/2004/10/rdf-schema/">
<rdfs:Class rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/Location">
<rdfs:subClassOf rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
</rdfs:Class>
<rdf:Property rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/geo-location">
<rdfs:domain rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/Location"/>
<rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Literal"/>
</rdf:Property>
<rdf:Property rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/civic-addr">
<rdfs:domain rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/Location"/>
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</rdf:Property>
<rdfs:Class rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/L2info">
<rdfs:subClassOf rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/Location"/>
</rdfs:Class>
<rdf:Property rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/apid">
<rdfs:domain rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/L2info"/>
<rdfs:domain rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/Location"/>
<rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Literal"/>
</rdf:Property>
<rdf:Property rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/ssid">
<rdfs:domain rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/L2info"/>
<rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Literal"/>
</rdf:Property>
<rdf:Property rdf:about="http://www.networkdiscovery.org/2004/10/rdf-schema/phymac-type">
<rdfs:domain rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/L2info"/>
<rdfs:range rdf:resource="http://www.networkdiscovery.org/2004/10/rdf-schema/PHYMACClass"/>
</rdf:Property>
... (SNIPPED...)

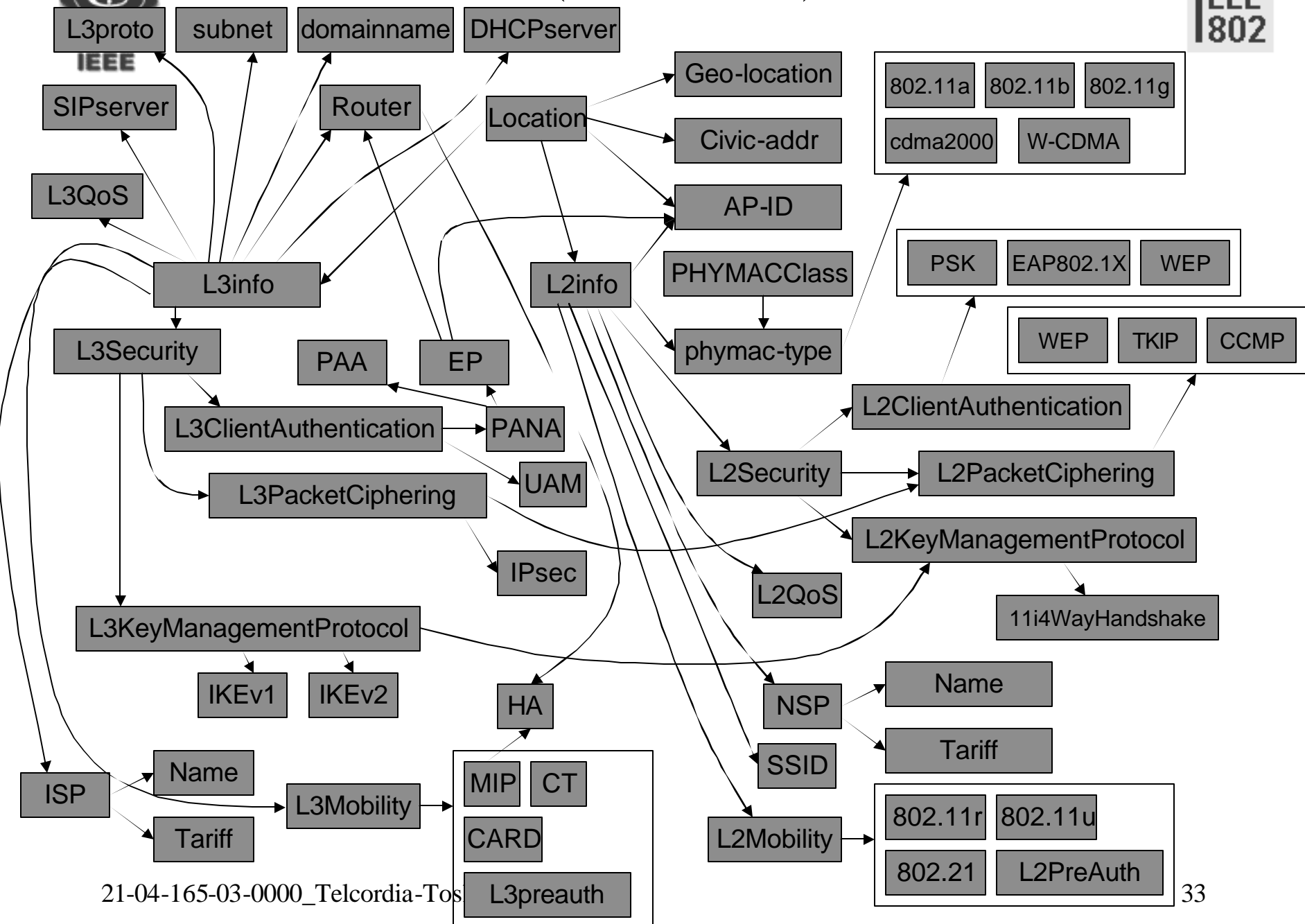
```



Graphical View of the Schema



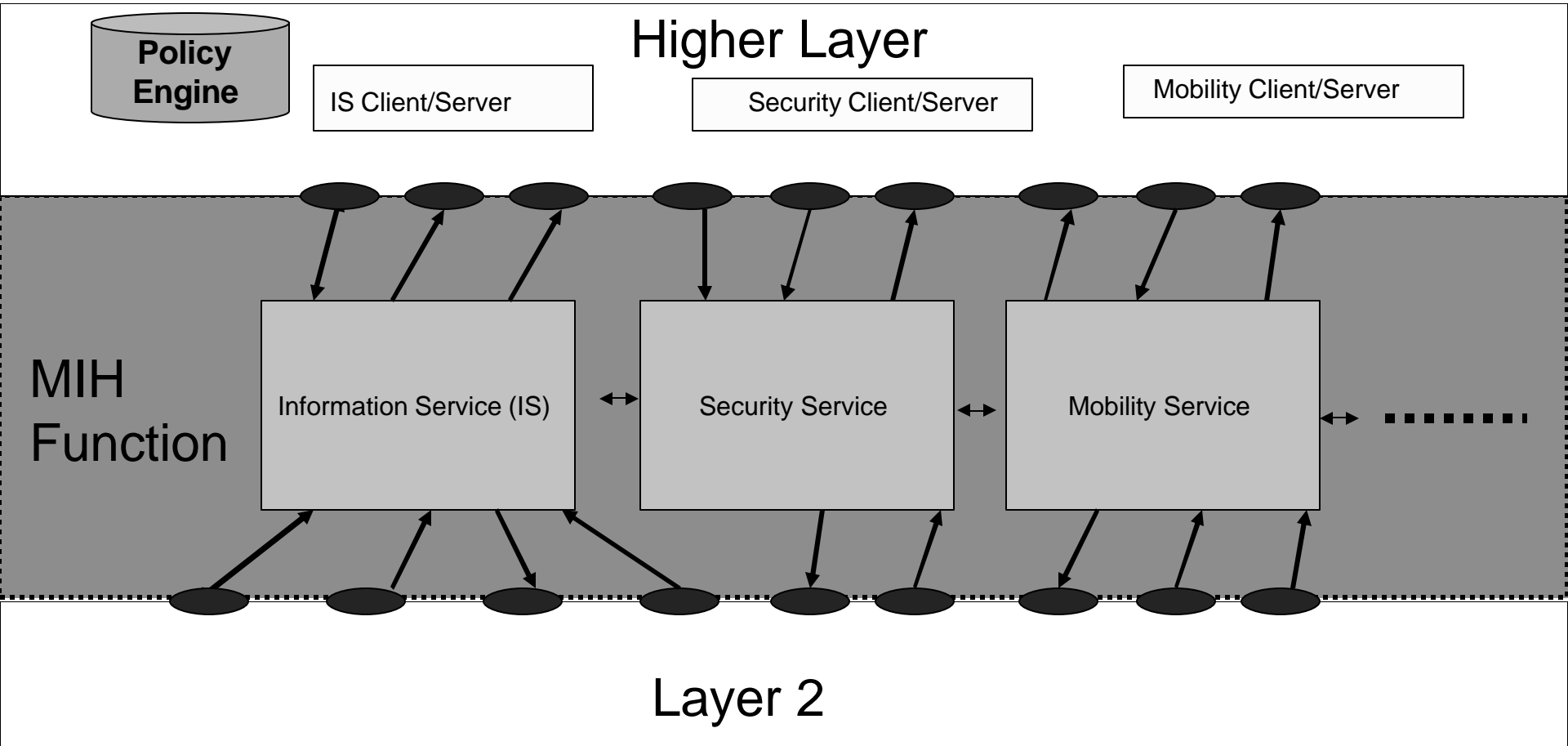
RDF Schema for AIS (detailed view)





Event Triggers

MIH Functional Model with SAPs





Local Triggers from lower layer (lower SAP)

- Link_going_down_indication (time, link_id)
- Link_going_down_response (time, link_id)
- Link_down_indication (link_id)
- Link_down_response (link_id)
- Link_up_indication(link_id)
- Link_up_response(link_id)
- Additional_link_available_indication (link_id)
- Additional_link_available_response (link_id)



Functional Primitives to/from lower layer (Lower SAP)

- Register_event_request(event_type, parameters)
- Register_event_confirm(event_type, parameters)
- Link_characteristics_request(delay, throughput, pkt_err, ...)
- Link_characteristics_confirm(delay, throughput, pkt_err, ...)
- Information_request(location_type, location_value, condition, ...)
- Information_confirm(.....)
- Set_parameters_request(...)
- Set_parameters_confirm(...)
- Link_change_request(link_id)
- Link_change_confirm(link_id)



Functional Primitives to/from higher layer (Higher SAP)

- Register_event_request(event_type, parameters)
- Register_event_confirm (event_type, parameters)
- Pre_auth_request(Authentication_agent_address)
- Pre_auth_confirm (result, AP_id_list, AAA_key)
- Pre_config_request (configuration_agent)
- Pre_config_confirm (config_parameters)
- Handover_start_request (link_id, AR)
- Handover_start_confirm (link_id, AR)
- Handover_success_indication (link-id)
- Handover_success_response (link-id)
- Handover_faliure_indication (link-id)
- Handover_faliure_response (link-id)



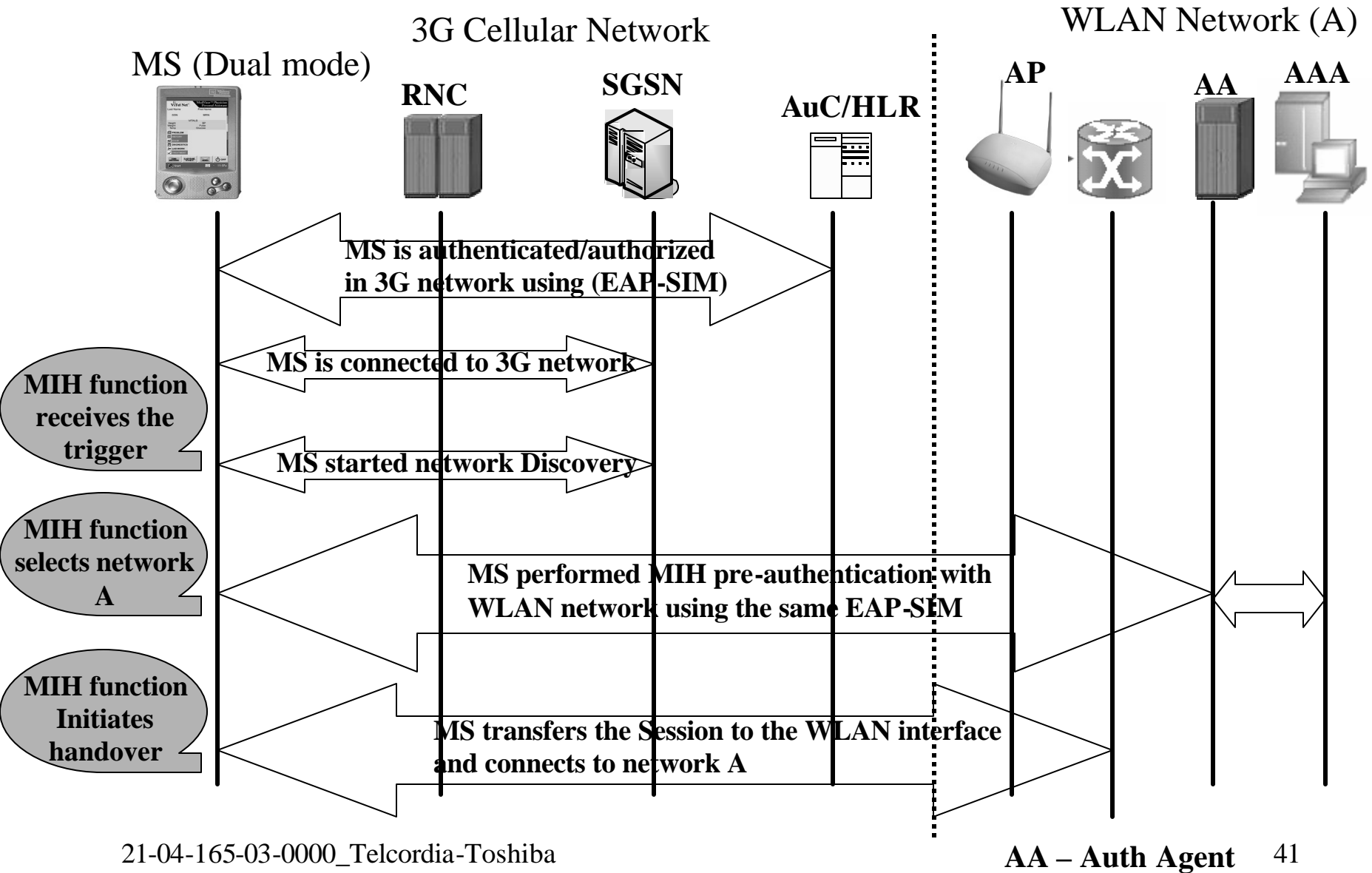
Remote Functional Primitives (to and from Network)

- Event_request (event_type, parameters)
- Event_confirm (event_type, parameters)
- Event_indication (event_type, parameters)
- Event_response (event_type, parameters)
- Information_request (location_type, location_value, condition)
- Information_confirm (...)
- Information_indication (location_type, location_value, condition)
- Information_response (...)

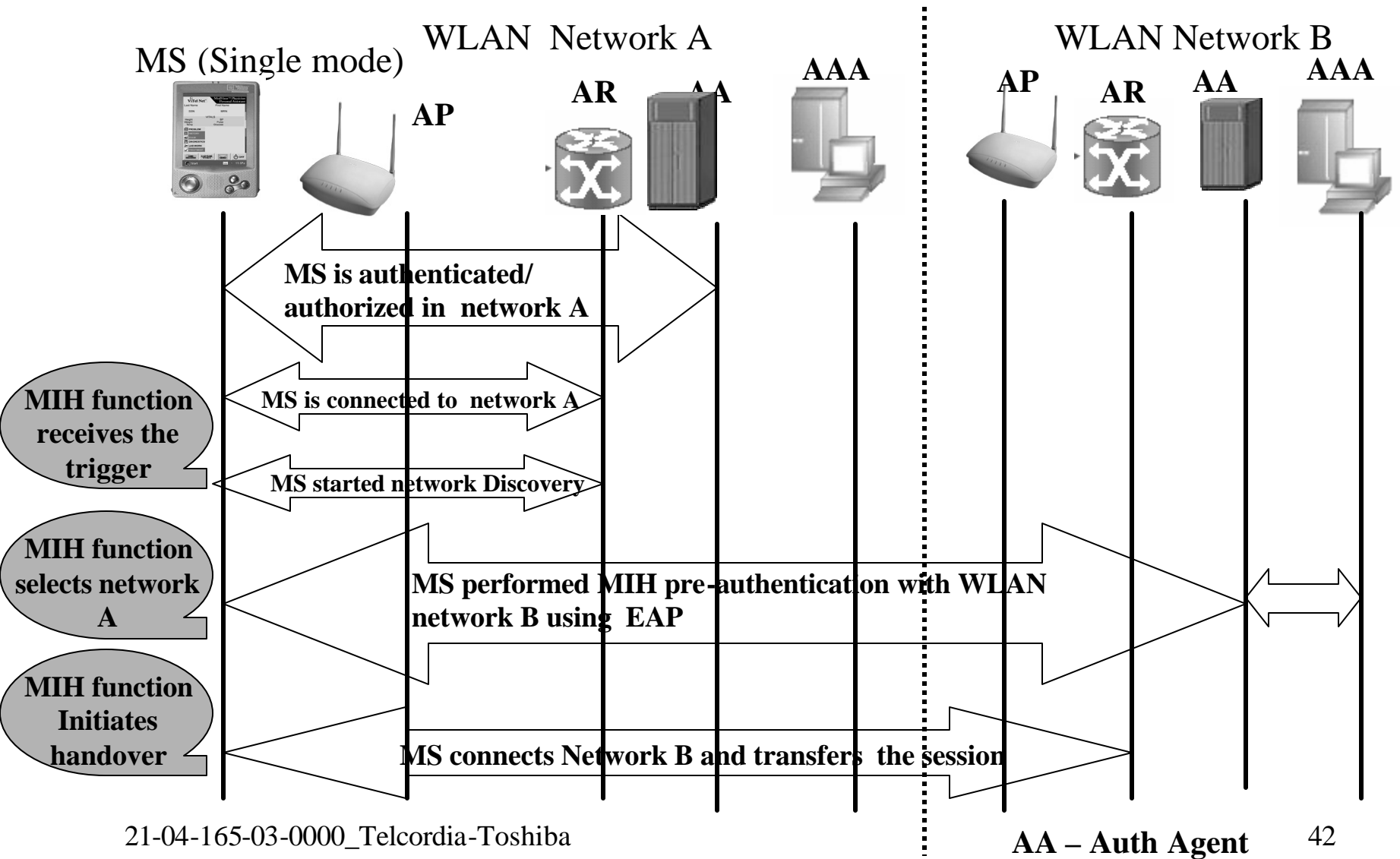


Handover Scenarios and Call Flow

Handover from Cellular to 802.11 Networks

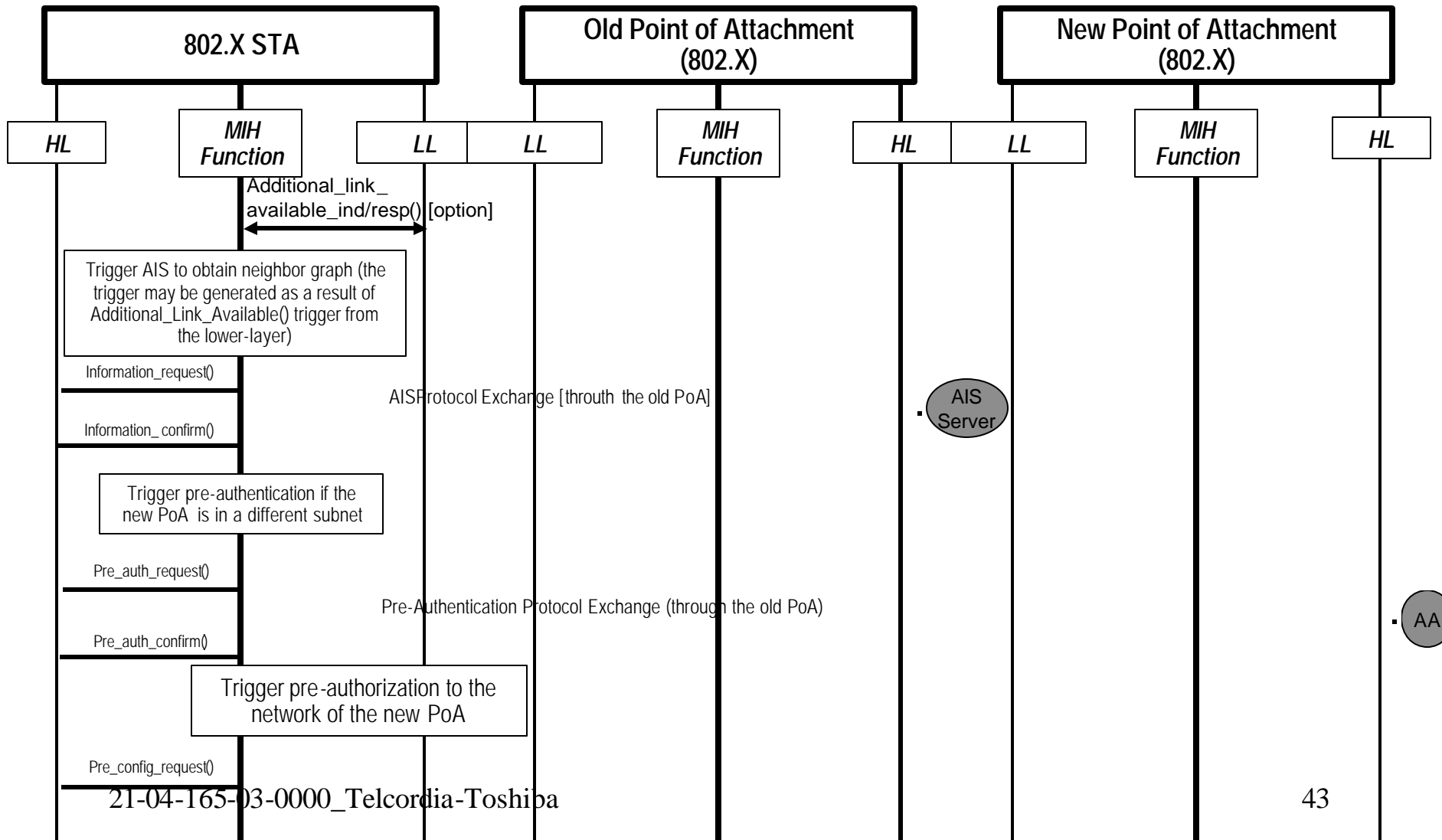


Handover between 802.11 Networks (Intra or Inter Domain)



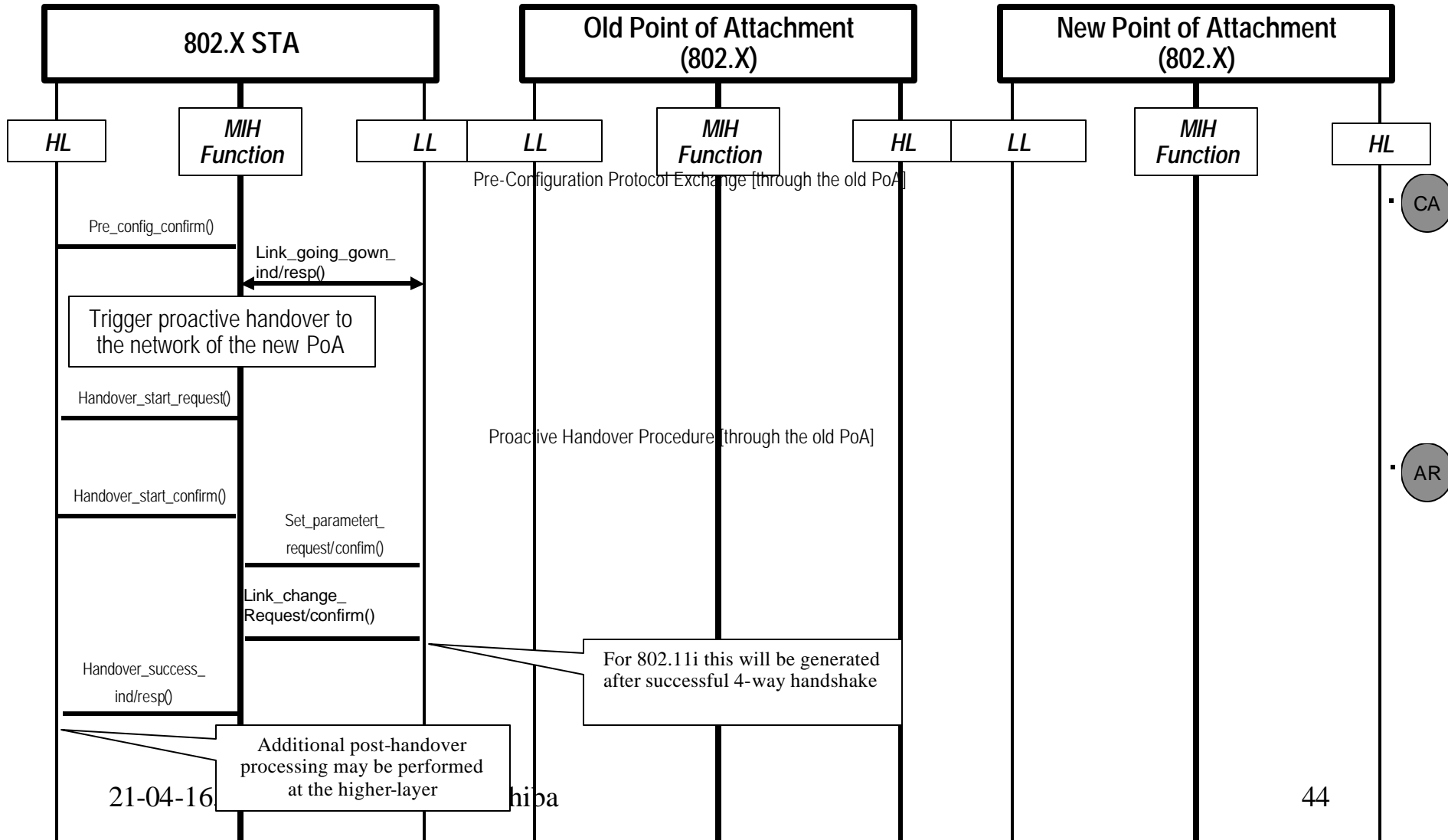


802.X to 802.X (Single I/F) Handover Call Flow



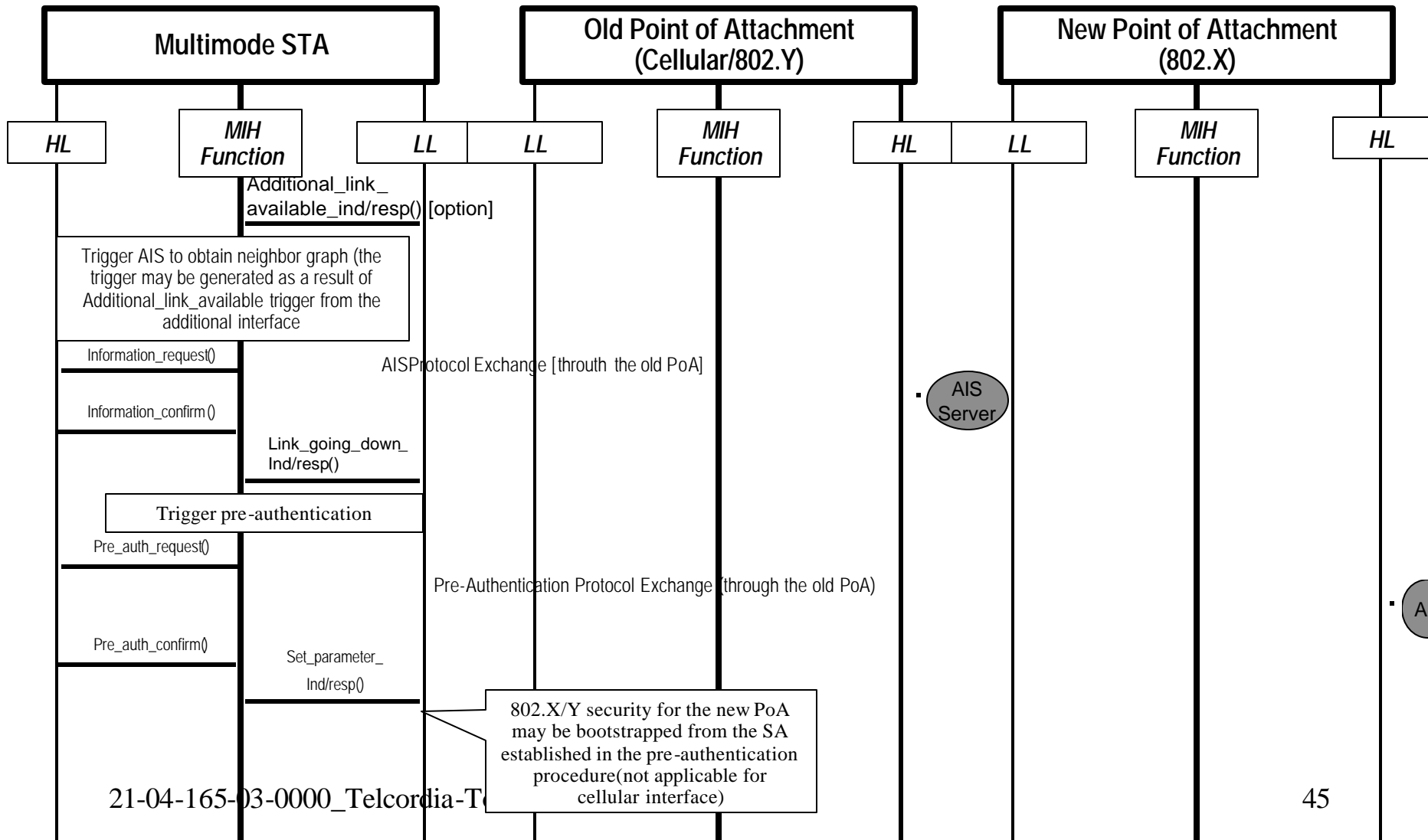


802.X to 802.X (Single I/F) Handover Call Flow (Cont'd)



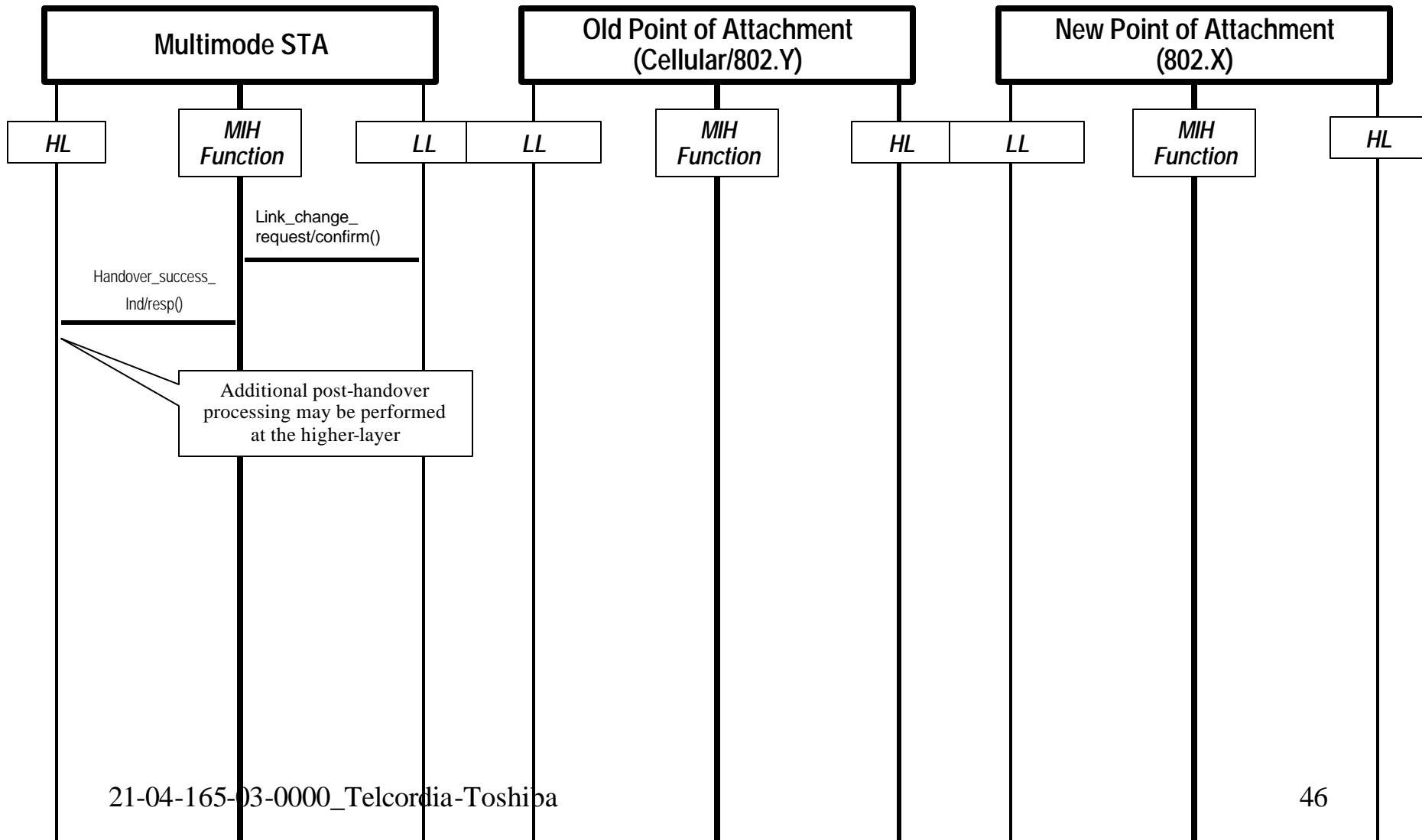


Cellular/802.Y to/from 802.X Handover Call Flow





Cellular/802.Y to/from 802.X Handover Call Flow (cont'd)





Mapping Between MIH Function and 3GPP Primitives (An Example)

| MIH Primitives | 3GPP Primitives |
|--------------------------------------|--|
| Link_going_down_indication/response | (CMAC_Measurement_REQ, CMAC_Measurement_CNF) |
| Link_down_indication/response | (CMAC_Measurement_REQ, CMAC_Measurement_CNF) or (CMAC_CONFIG_REQ, CMAC_CONFIG_CNF) |
| Link_up_indication/response | PHY_Access_CNF and/or (CMAC_CONFIG_REQ, CMAC_CONFIG_CNF) |
| Link_characteristics_request/confirm | CMAC_Measurement_REQ, CMAC_Measurement_CNF |



Mapping Between MIH Function and 802.11 Primitives (An Example)

| MIH Primitives | 802.11 Primitives |
|---|--|
| Additional_link_available_indication/response | (MLME_SCAN.request, MLME_SCAN.confirm) |
| Link_going_down_indication/response | (PLME_CHARACTERISTICS.request, PLME_CHARACTERISTICS.confirm) |
| Link_down_indication/response | (MLME_DISASSOCIATE.request, MLME_DISASSOCIATE.confirm) or MLME_DISASSOCIATE.indication |
| Link_up_indication/response | (MLME_ASSOCIATE.request, MLME_ASSOCIATE.confirm) or MLME_ASSOCIATE.indication ** |
| Link_characteristics_request/confirm | PLME_CHARACTERISTICS.request, PLME_CHARACTERISTICS.confirm |

** For 802.11i, 4-way handshake messages are required