Interworking Strategy between DVB-RCS and WiMAX

F. Rodriguez (Telespazio, Italy)
I.Melhus (SINTEF Norway)
L. Fan (University of Surrey UK)
A. Pietrabissa (University of Rome “La Sapienza”, Italy)
C. Baudoin (Alcatel Alenia Space, France)
Z. Sun (University of Surrey UK)

TELESPAZIO
A Finmeccanica / Thales Company

Summary

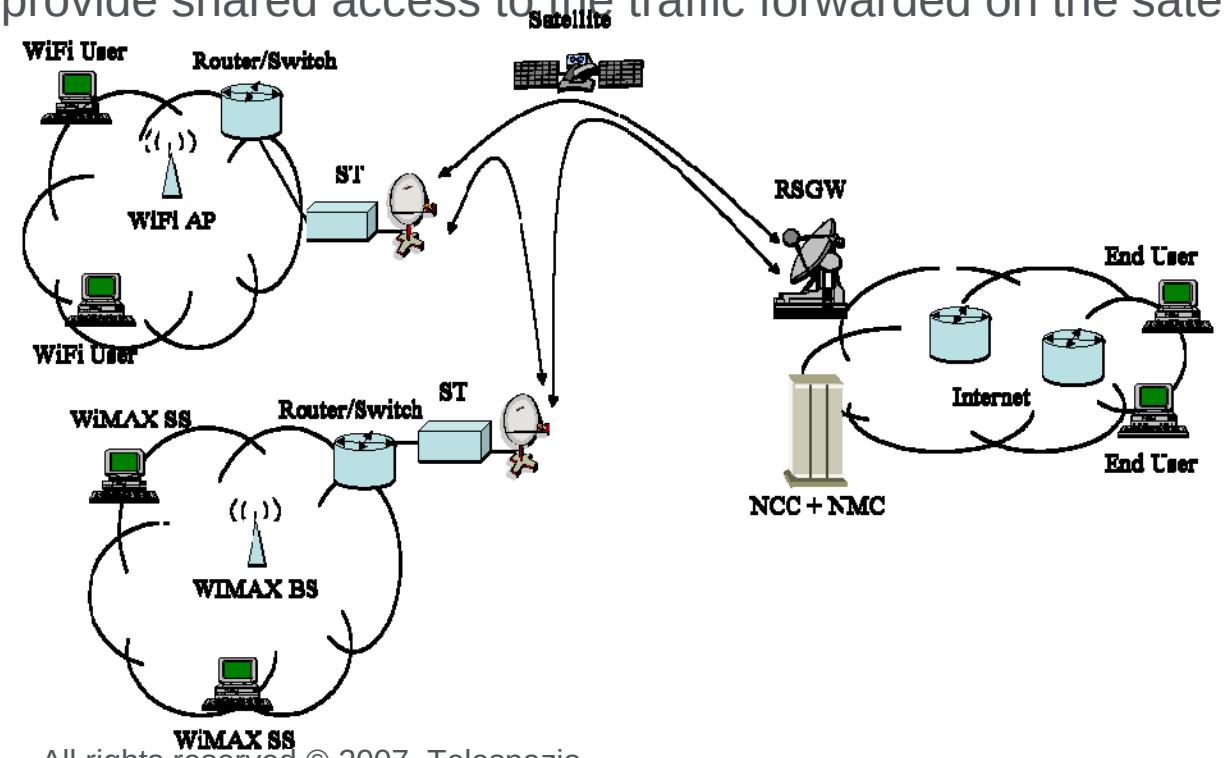
- SATSIX project overview
- Introduction
- General Architecture
- Problem Analysis
- SATSIX interworking strategies: QoS and Mobility
- Conclusions

Introduction

- The focus of the presentation is on the strategy that supports the integration of hybrid satellite and WiMAX in the framework of the Satsix Project.
- The aim is to provide low-cost universal broadband access through terrestrial wireless access like Wimax as Local Loops, providing a universal access to rural and marine areas.
- Problems will be described concerning the interworking between Digital Video Broadcasting – Return Channel via Satellite (DVB-RCS) system and Worldwide Interoperability for Microwave Access (WiMAX)
- Solutions adopted in the SATSIX research project will be presented.

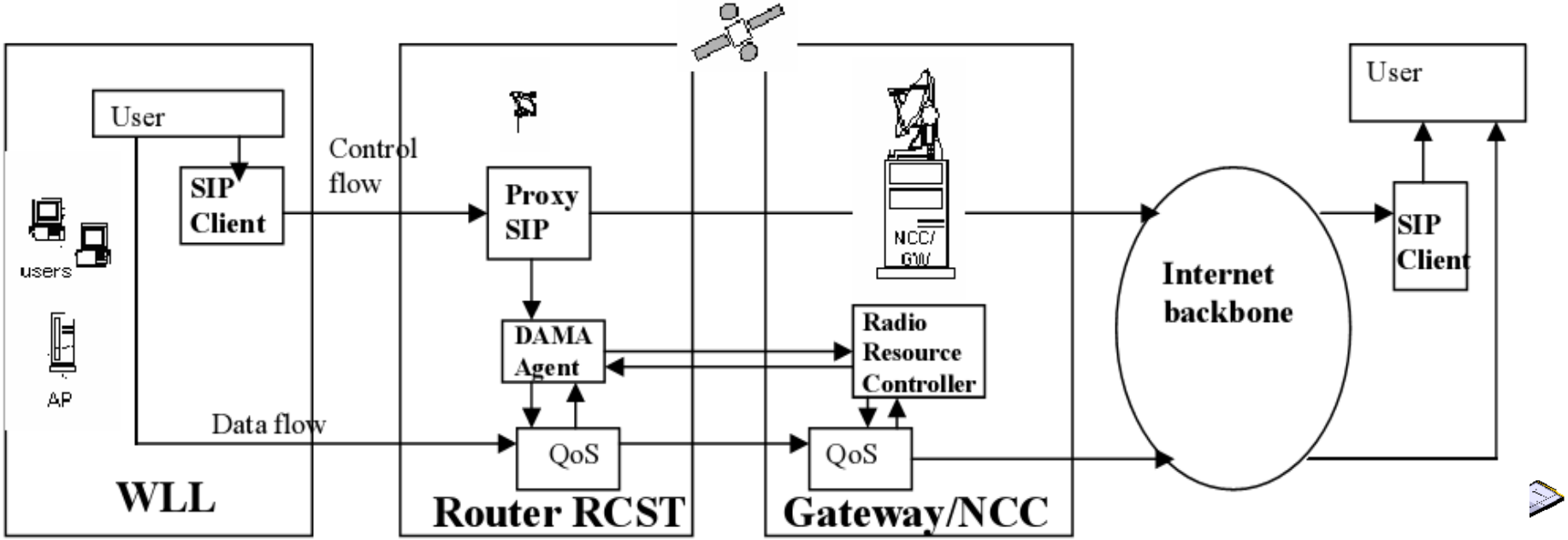
Satsix network architecture

- The SATSIX network architecture may be applied to two network scenarios:
  - the transparent star
  - The regenerative mesh/star.
- Both WiFi and WiMAX terrestrial access networks may be connected to the RCSTs to provide shared access to the traffic forwarded on the satellite link.



QoS Interworking Issues analysis

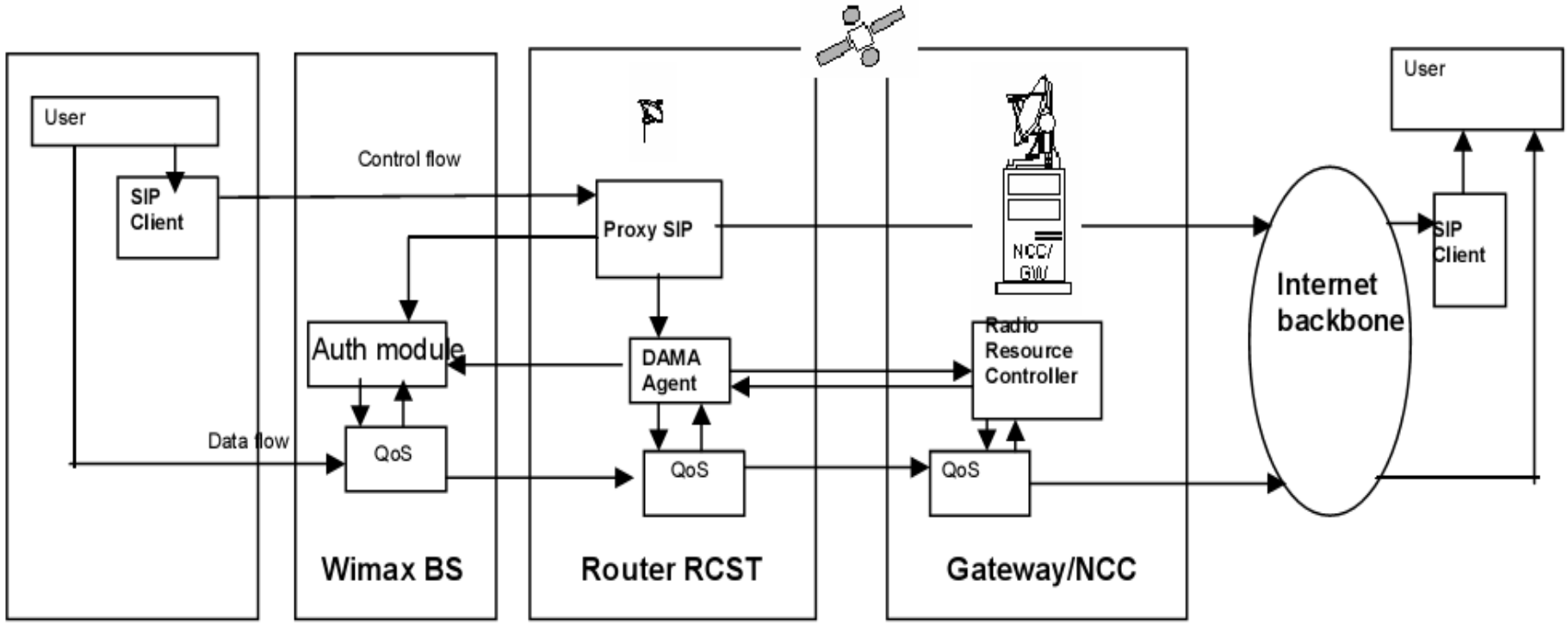
- A WiMAX Base Station (BS) can be connected through a LAN interface to the SATSIX terminal
- The access of SS is made at MAC level through the set up of connections.
- A connection set up can be accepted at MAC level without any parameter exchange with the SATSIX node
- No mean to negotiate the QoS parameters compatible with the more bandwidth critical node except from the use of SIP.



Drawbacks of QoS interworking

- First: at DAMA level, because the possible overriding of the provisioned QoS parameters negotiated after SIP negotiation.
  - After the SIP set up a set of QoS parameters has been accepted at SATSIX level, and at WiMAX service provision.
  - The SS can modify its behaviour and renegotiate the QoS parameters of the active CID (this renegotiation cannot be intercepted by the DAMA manager)
- Second: the traffic inside the WiMAX network is managed following WiMAX specification
  - traffic directed to the SATSIX node may not be accepted by the Satellite network due to possible saturation of queues.
- A possible strategy: dynamic definition and change of service flows, foreseen in WiMAX specifications.
  - There should be an information exchange between the WiMAX “Authorization module” and the DAMA managing function for a dynamical redefinition of QoS parameters before allowing any change in the service flow profile.

Reference architecture for QoS interworking



SATSIX QoS interworking strategy (1/3)

- Two groups of users can interface to the WiMAX network
  - Users managing connections inside the local loop network
  - User managing connections outside the local loop network and possible going to the satellite sub-netwok.
- In the first case the generated traffic is networked by the local nodes; in the second case the traffic must be networked also by the satellite nodes.
- When a new application starts, a SIP session must be set up;
  - the SIP INVITE message must contains the following header fields: To, From, CSeq, Call-ID, Max-Forwards and Via.
  - SDP messages include information about QoS requirements for that SIP session, that are used by the RCST to negotiate the bandwidth allocation with the NCC.
- The connection characteristics (i.e. the QoS parameters) in the SDP message are intercepted by the SIP proxy (in the RCST) and forwarded to the QoS agent.

SATSIX QoS interworking strategy (2/3)

TELESPAZIO
A Finmeccanica / Thales Company

- Then the RRM module is triggered in order to manage the dynamic bandwidth allocation in the satellite sub-network. This can be performed both at IP and MAC level, by MAC QoS module.
  - In the latter the class of services are mapped onto the DVB-RCS capacity requests (i.e. Continuous Rate Assignment (CRA), Rate Based Dynamic Capacity (RBDC), Volume Based Dynamic Capacity (VBDC), Absolute Volume Based Dynamic Capacity (AVBDC) and Free Capacity Assignment (FCA)).
  - The capacity requests are sent to the NCC via SYNC burst, according to DVB-RCS standard, and the capacity, if available (a connection admission control algorithm is required) is allotted by NCC in the TBTP after a round trip delay.

SatSix

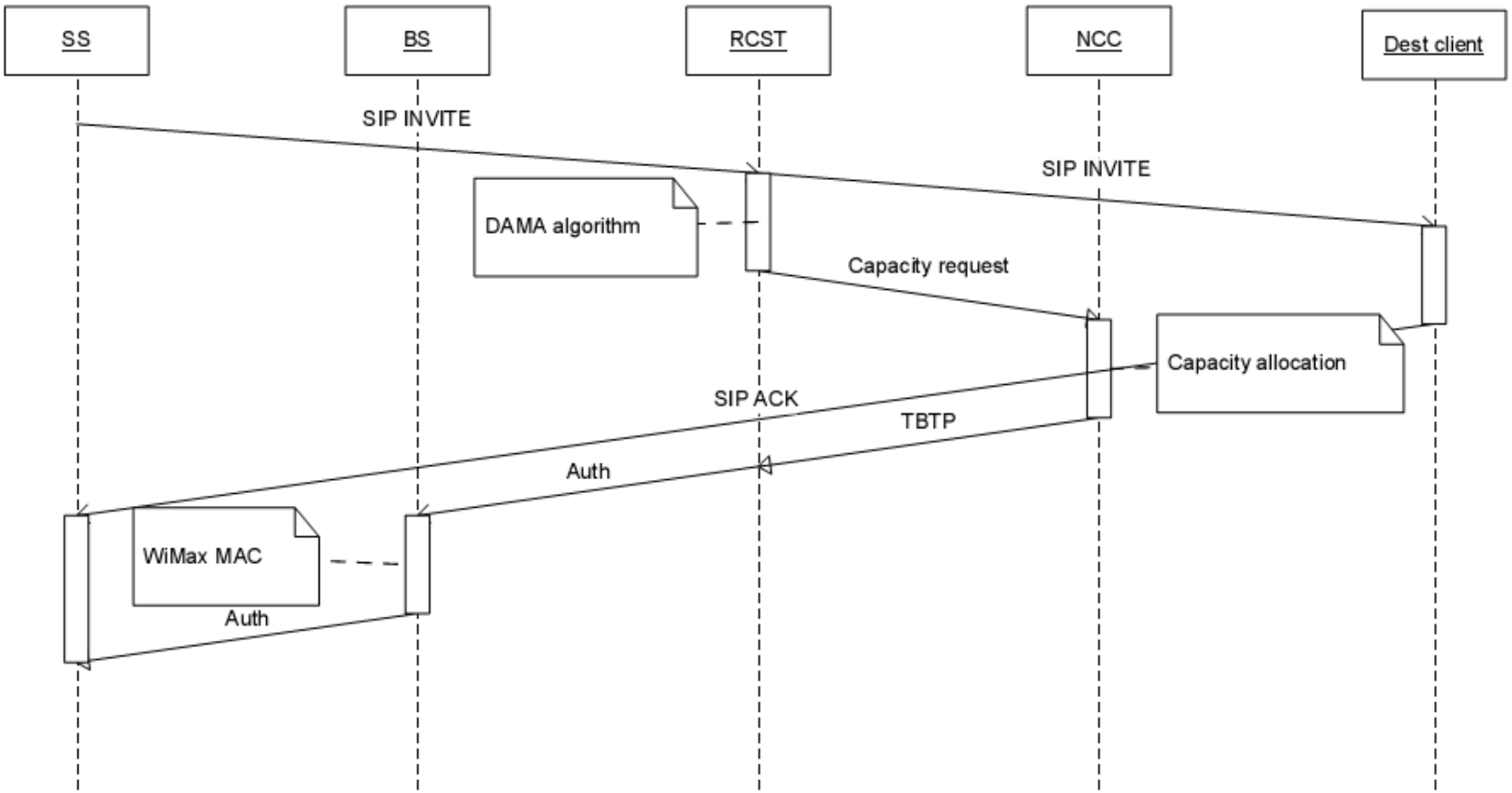
SATSIX QoS interworking strategy (3/3)

TELESPAZIO
A Finmeccanica / Thales Company

- Recalling the initial scenario description
  - in the first case the WiMAX node behaviour is the same as in a terrestrial network; the Authorization Manager on the basis of the available resources can accept or not the establishment of new service flows.
  - in the second case the architecture foresees a SIP interaction also with the BS node. In this case the QoS parameters must be compatible between the wireless terrestrial network and the satellite network; so that the WiMAX management of the incoming connection requests must wait for the protocol interaction between RCST and NCC.
- Bandwidth allocation response is then returned to the BS and if enough band and QoS guarantee is stated, the Authorization Manager can accept the connection requests and if the grant has success it can establish the MAC connection at WiMAX level, allowing then the application to start sending packets.
- By this way if the dynamic bandwidth allocation is allowed at WiMAX node then the application now can re-negotiate the QoS parameters through SIP.

SatSix

WiMAX – Satellite subnetwork interaction sequence diagram



Mobility management issues

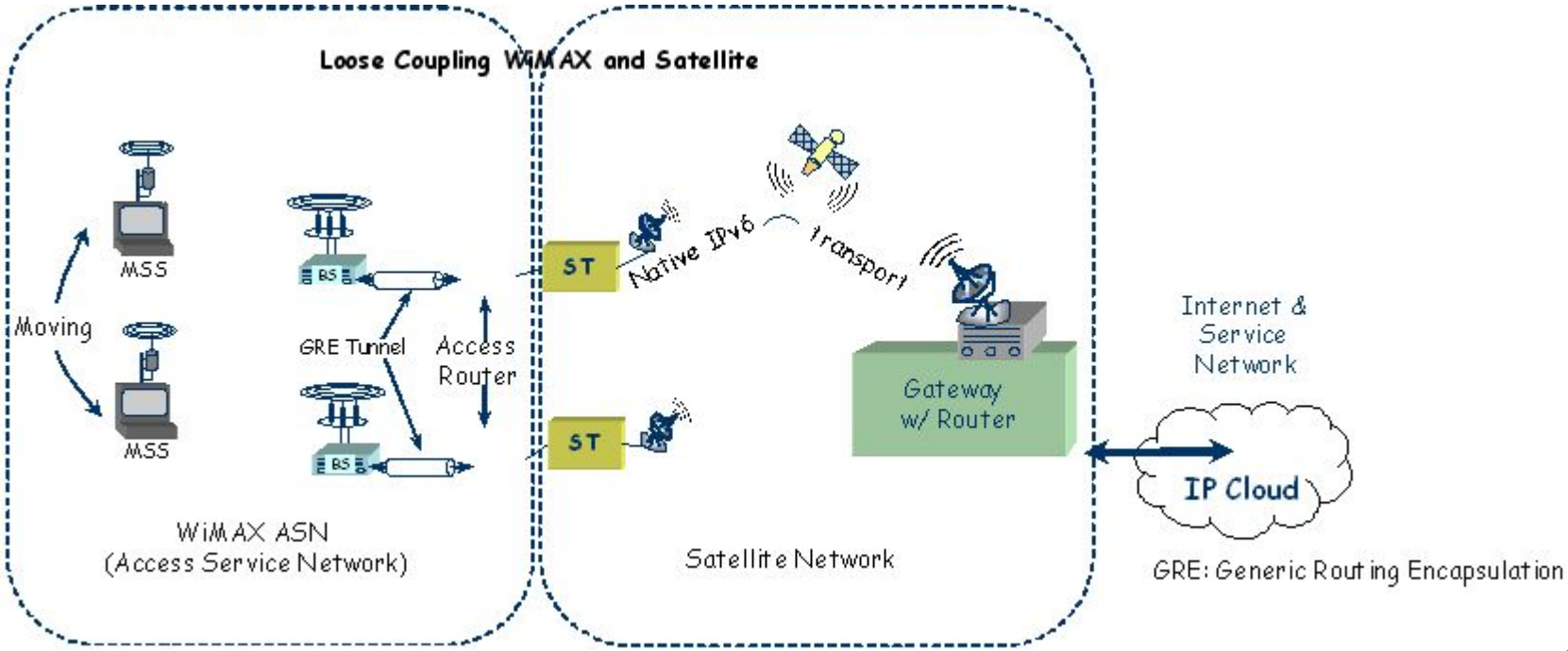
TELESPAZIO
A Finmeccanica / Thales Company

- IEEE 802.16 is a connection oriented access technology (without bi-directional native multicast support)
- This may be a problem for some IPv6 protocols, e.g. IPv6 ND (Neighbour Discovery).
- This is additionally complicated by the definition of the commercial network models found in WiMAX, (the transport connection is defined to extend the 802.16 MAC transport connection all the way to an access router, by establishing a tunnel between the base station and the access router).
- This leads to multiple ways of deploying IP over 802.16 based networks.

SatSix

IP over Wimax deployments 1

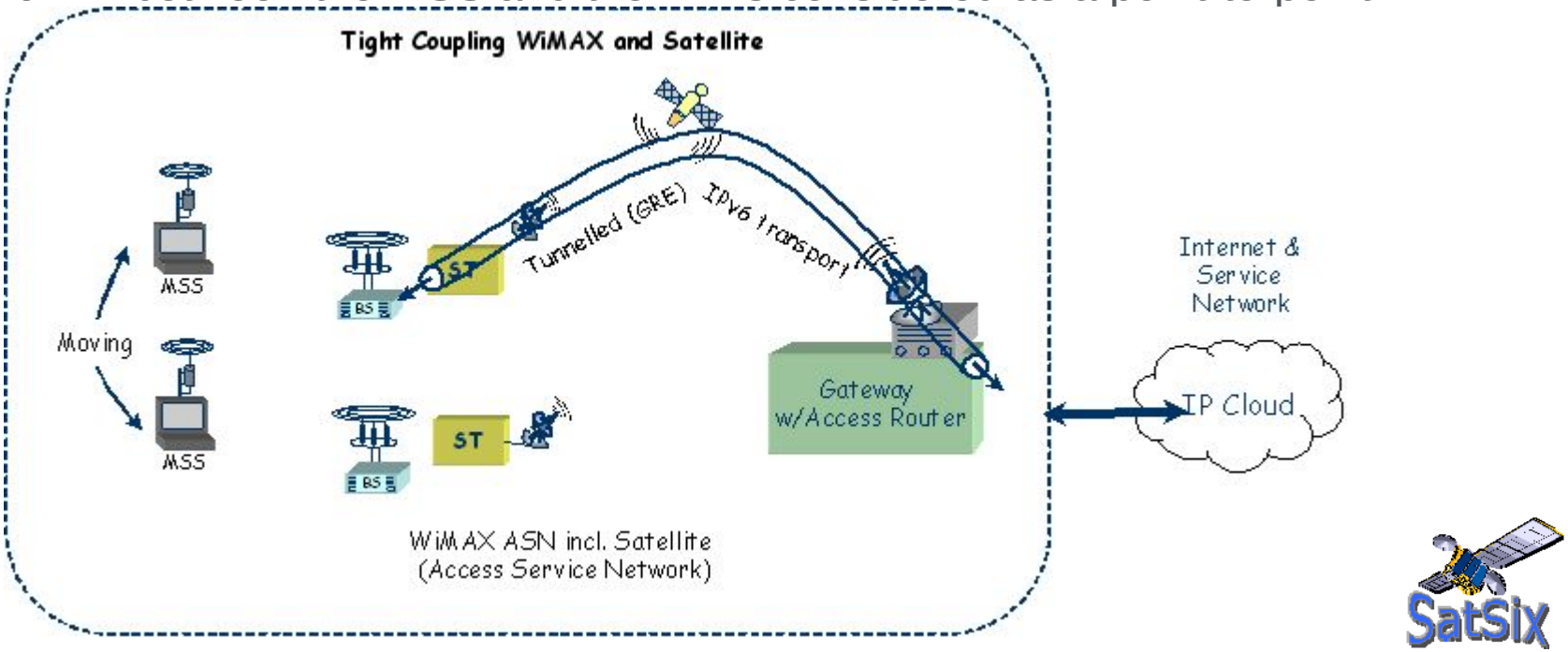
- The WiMAX Subnet consists of a single BS/AR and multiple MSSs (Mobile Subscriber Station)
- a single address prefix is allocated to each attached MSS.
- the IP Network Service is performed by native IPv6 transport over the satellite link.



IP over Wimax deployments 2

The access router is located at the satellite gateway separated from the BS

- The WiMAX transport mechanisms are extended to the satellite network
- The satellite is included in the WiMAX network.
- The WiMAX Subnet consists of a single AR with multiple BSs and MSSs and where a shared address prefix is used by all attached MSSs.
- In this scenario the IP network service is performed by an IP tunnel over the IPv6 Convergence Sublayer (802.16e/WiMAX solution) over the satellite link. The IPv6 link between the MSS and the AR is considered as a point-to-point link.



SATSIX Mobile interworking strategy

- Two alternative scenarios has to be studied for WiMAX mobility management:
  - **Scenario A**: Client Mobile IP (CMIP), where the Mobile Client resides in the MSS. For mobility within the WiMAX network using CMIP, the point of attachment CoA (Care-of Address) changes when subnet changes.
  - **Scenario B**: Proxy Mobile IP (PMIP), where the Mobile Client resides in the access router. The Proxy MIP solution does not involve a change in the point of attachment address when the MSS moves. There is no need for the terminal to implement a client MIP stack.

Scenario A: Mobile Client resides in the MSS
Scenario A1: Tunneling

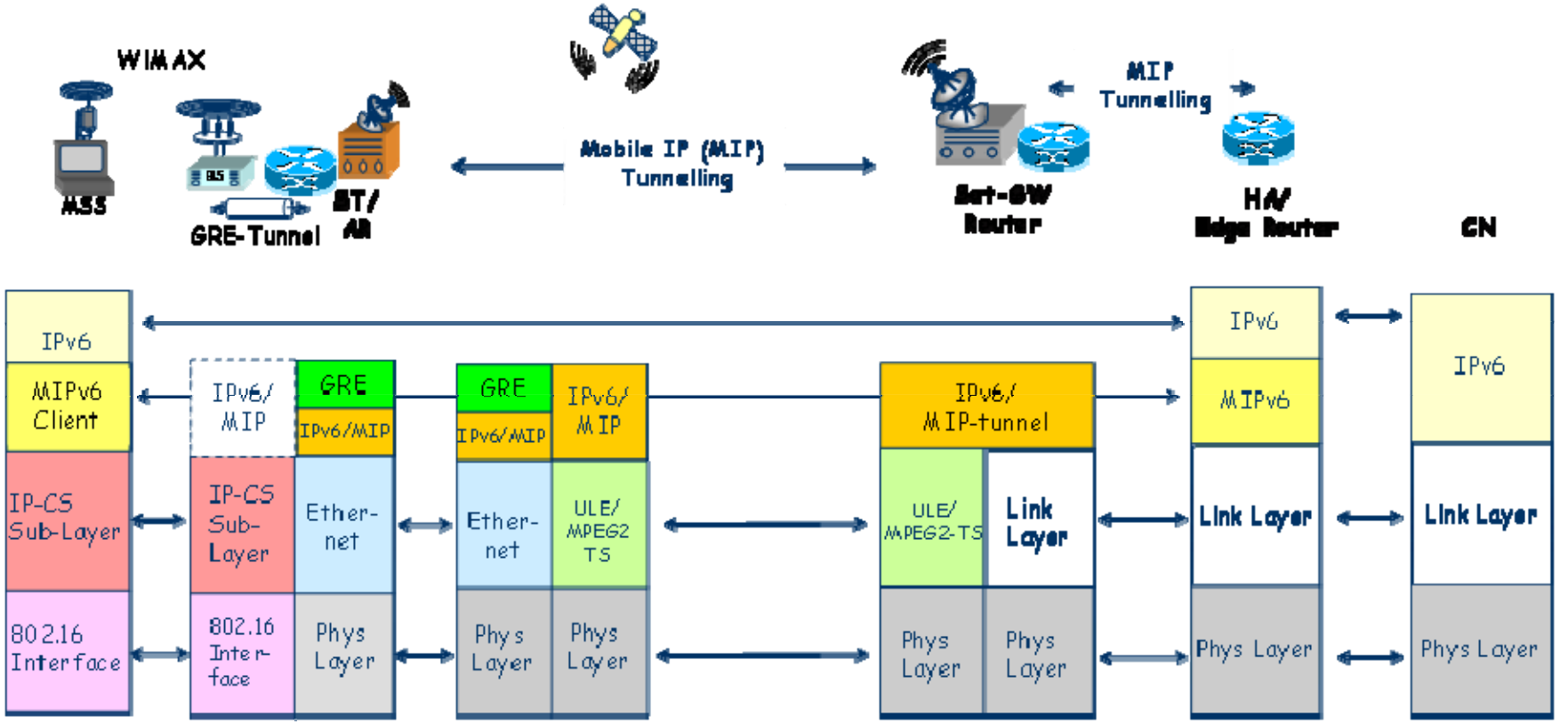
TELESPAZIO
A Finmeccanica / Thales Company

- Scenario A1: The satellite link is not incorporated as part of the WiMAX access network, the CMIPv6 resides at MSS, access router at WiMAX BS/satellite terminal, and tunneling is performed via Home Agent.
- the Access Router is connected to the Base-station via a GRE tunnel.
- The MIPv6 capable MSS needs information about the Home Agent or home link and/or its Home Address (HoA) in order to initiate MIPv6 signalling towards the Home Agent
- The MSS acquires the information required for establishing a MIPv6 session via DHCPv6
- After obtaining the HoA (global scope IPv6 address) via the DHCP response, the CMIPv6 client shall send a BU (Binding Update) to the Home Agent to register it's binding to the CoA.
- If the MSS received the HoA in the DHCP reply message, the MSS shall set the HoA field in the BU to the received HoA
- An IP-in-IP tunnel is established between Home Agent - Sat-GW/Router – BS/RCST/Access Router (MIPv6 tunnelling over the satellite link).

SatSix

Scenario A1: tunneling

1) Client-MIP:
MIPv6 Data Plane with MIP Tunneling via HA,
integrated BS and Access Router at Terminal side

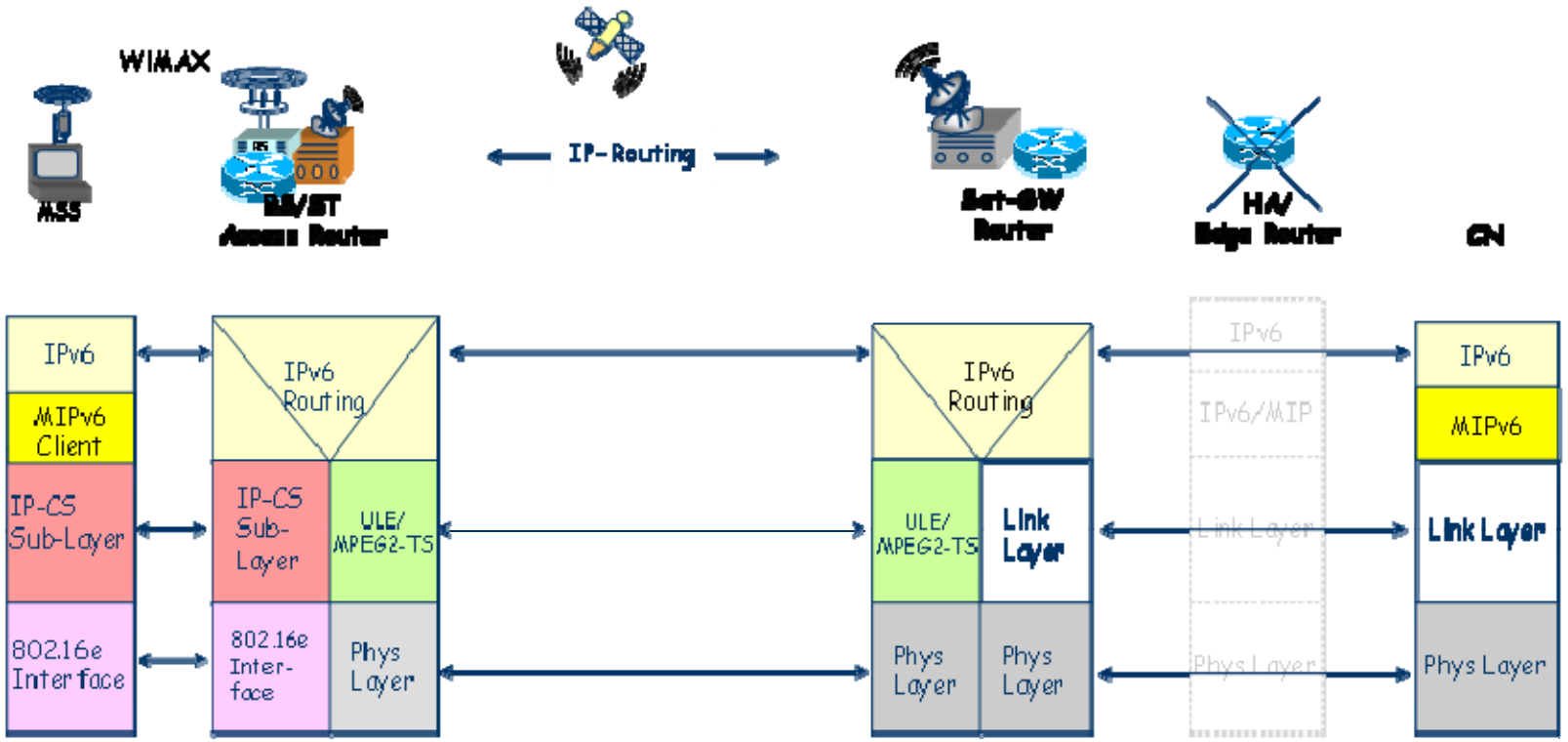


Scenario A2: no tunneling

- **Scenario A2:** The satellite link is not incorporated as part of the WiMAX access network, CMIPv6 resides at MSS, access router at WiMAX BS/satellite terminal, and route optimization has been performed
- no tunnelling via Home Agent.
- Due to the MIPv6 route optimization there is normal IPv6 packet transport between the CN (Correspondent Node) and the MSS and vice versa, without any MIPv6 tunnel. This means less overhead over the satellite link.

Scenario A2: no tunneling

2. Client MIP
MIPv6 Data Plane with Route Optimization,
integrated BS and Access Router at Terminal side



Scenario B: Mobile IP proxy client resides at access router

TELESPAZIO
A Finmeccanica / Thales Company

- Proxy MIP6 (PMIPv6) is a solution that is aligned with the architectural direction of WiMAX
- PMIPv6 is one of the network-based mobility management protocols which can avoid tunnelling overhead over the air/satellite-link, as well as mobile host's involvement in mobility management.
  - The same MIPv6 Home Agent can be used be used at the same time with little or no modifications for clients that support MIPv6 and for clients that don't have host mobility software (does not require to have the MIPv6 protocol stack) and would like the network to handle mobility for them.
  - Re-use of supporting work that has been done for MIPv6. This includes the ability to establish security associations, RADIUS and Diameter extensions, bootstrapping, dual stack support, reliability, fail over and HA switching.

- PMIPv6 introduces a new entity, Proxy Mobile Agent (PMA), which is a functional element on the access router acting as a relay node between the Home Agent and the mobile station.
- The PMA performs the mobility signalling on behalf of the mobile station by establishing a bidirectional tunnel between the Home Agent and the proxy mobile agent.

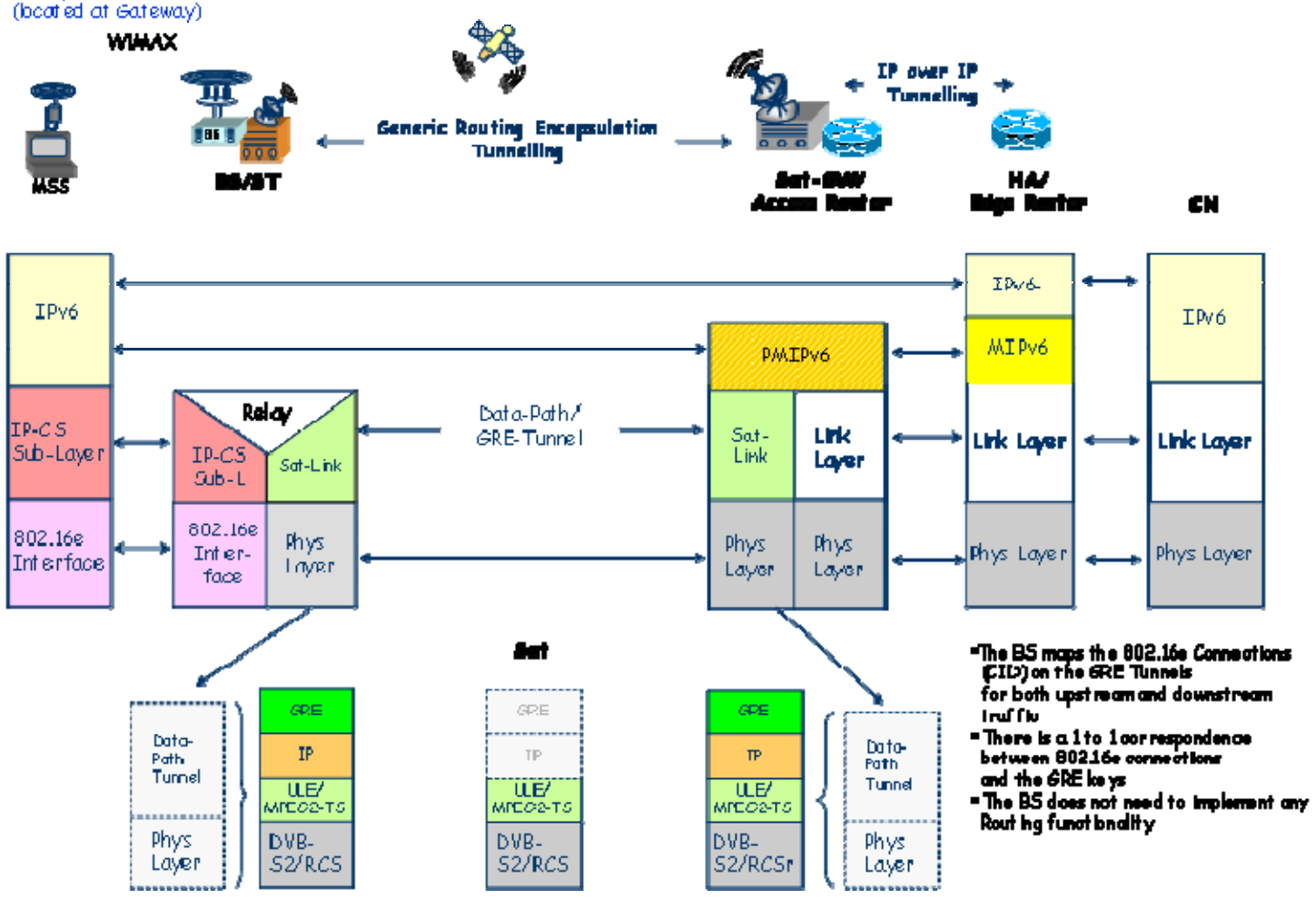
SatSix

Scenario B

- The satellite link is incorporated as part of WiMAX network, no Mobile IP client at MSS, the PMIPv6 resides at access router/satellite gateway and there is tunnelling via Home Agent
- A PMIPv6 is placed at the Sat-Gateway/Access Router.
- The connection between the Home Agent and the Access Router is set up by an IP-in-IP tunnel, while there is a GRE tunnel over the satellite link between the Access Router and the WiMAX BS per MSS basis.
- The BS maps the IEEE Connections (CID) on the GRE tunnel for both downstream and upstream traffic.
- There is a 1 to 1 correspondence between the IEEE 802.16 Connections and the GRE Keys.
- The BS does not need to implement any IP routing functionality.

Scenario B

3. Proxy MIP (PMIPv6)
MIPv6 Data Plane with Tunneling via HA,
BS separated from Access Router
(located at Gateway)



Conclusions

- Firstly, the reference network architecture has been presented, with the relations between each node, in particular the WiMAX users and the WiMAX base station, and the WiMAX base station and the DVB-RCS system.
- Secondly, the main requirements of the smooth interworking between DVB-RCS and WiMAX are analysed.
- Different aspects of IPv6 WiMAX mobility, related both to the mobility within a standalone WiMAX network and mobility when WiMax network is loosely or tightly coupled to a satellite network have been shown
- Finally, interworking strategies, considering the communication of different types of traffic sources covered by a Wimax BS and connected to satellite DVB-RCS networks, are proposed.

Thank you!

Filippo Rodriguez
Telespazio S.p.A.
Via Tiburtina 965, 00156 Rome, Italy
Tel +39 06 4079 6336
Fax +39 4099 9607
Filippo.rodriguez@telespazio.com