ETARE
ENABLING TECHNOLOGY FOR ADVANCED RADIO IN EUROPE

An Architecture for Enabling migration of tactical networks to future flexible Ad Hoc WBWF

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- Rationale
- Operational scenarios
- Wideband Waveform Architecture requirements
- Architecture of the Wideband Waveform
- Layers features
- An example : Handling flat and/or clustered network

Rationale

- Various applications, various QoS
  - Low to high data rate : rate granularity
  - Latency from real time to background
  - Block error rate (speech ≠ data)
  - Packet or connection oriented
- Interoperability
  - Nations/Coalitions
  - Manufacturers

  → Standardised interfaces and protocols
- Development, production, maintenance and deployment cost
- Product confidence
- Scarce frequency spectrum → bandwidth usage flexibility
- Facilities for future progressive insertion of new technologies (WBWF evolutivity)

Operational scenarios

- OTM (On The Move)
  - Multi-hop mobile Ad Hoc Network (self organisation of the network)
  - Fleets of terminal types : portable, vehicular, aero-mobile
- ATH (At The Halt)
  - Some of the terminals are fixed or semi-fixed, e.g. a mobile stops and deploys a mast mounted gain antenna
  - Enhanced communication capability : data rate, coverage
  - Can be used as backbone to infrastructure or other OTM parts
- NLI (Naval and Land Interworking)
  - Communications between OTM terminals and boat mounted equipment
- *(WSW - Weapon System Waveform)*

Different scenarios – Different System characteristics

- Types of missions/coalition configuration : different security levels
- Terminals behaviour : power management, transmission capabilities, support of Classes of Service, etc.
- Types of traffic with varying QoS requirements (IP services, connection oriented services, connectionless short messages, etc.)
- Types of operational theatre
  - Propagation environments, interference conditions and needs for signal discretion.
  - Coverage areas : densely (up to 200 nodes) as well as sparse
  - Types of network topology
- Frequency bands "agnostic"
  - NATO UHF band in a first step as the core band for OTM scenarios
  - other frequency bands either static configuration (NATO UHF rescheduling easily supported, or dynamic during operation (cognitive radio).

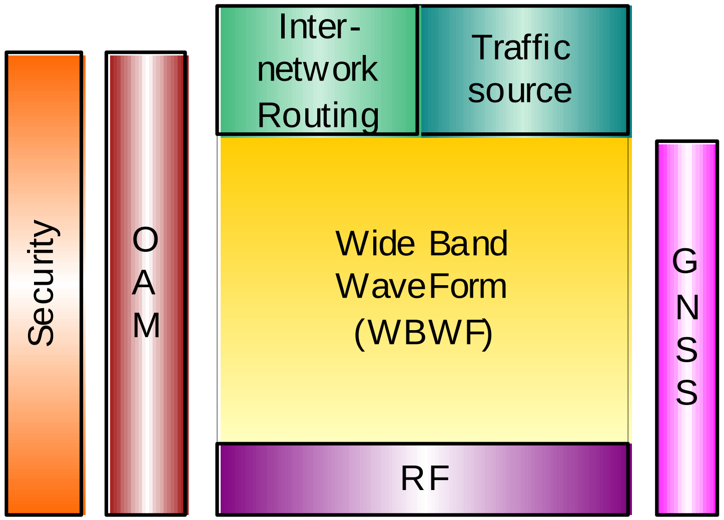
WBWF Architecture Requirements

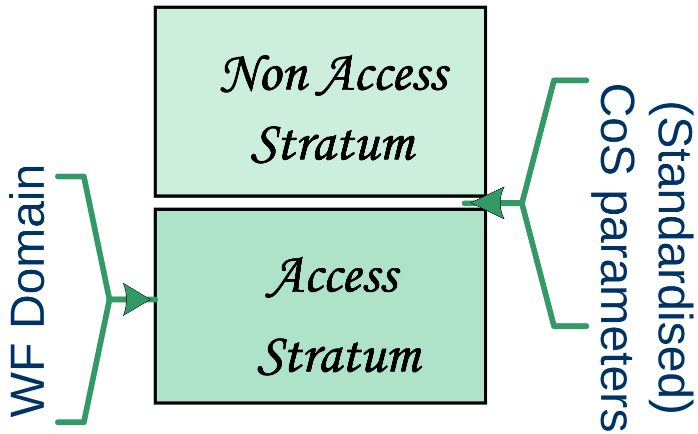
- Several multiple access schemes TDMA OFDMA SC-OFDMA, FH-CDMA, DS-CDMA, hybrid access schemes, transitions between them
- Dynamic physical layer configuration for transport format adaptation
- QoS adaptation with radio resource management algorithms for link adaptation
- Boost future standardization of the interfaces for inter-operability
  - Inherits a similar OSI and cross layer behaviour than relevant standards and developments from the civil telecommunication domain, with adaptation to ad hoc and military constraints → fasten standardisation
  - Flexible enough to accommodate
    - progressive insertion of future radio technologies
    - Keeps encapsulated proprietary algorithms
    - Keeps encapsulated proprietary strategic matters (security, …)

WBWF Architecture Requirements (con't)

- Optimization of spectrum efficiency and signalling consumption : several resources management strategies and protocols
  - Flat routing and radio resource management
  - Clustering of the management of radio resources :
    - a node is Cluster Head and allocates resources to its neighbours
    - but the traffic is not concentrated to it : traffic remains distributed.
    - Cluster Gateways at interconnections
  - Hierarchical clustering : nodes are organised in a hierarchical tree topology, some of them centralize
    - traffic for their upper level
    - optionally radio resource management for their lower level
- Security with the protection of
  - intra-network protocol signalling (NETSEC)
  - traffic and signalling information that transit over the radio interface (COMSEC)
  - the physical signal (TRANSEC)

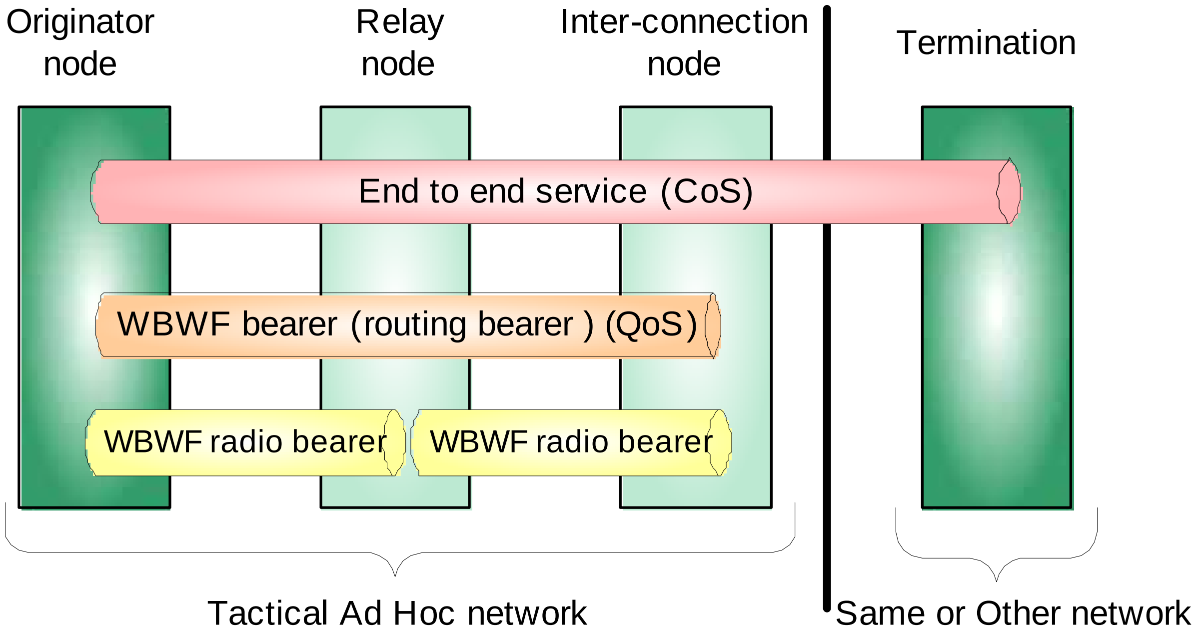
Architecture of the WBWF (perimeter)





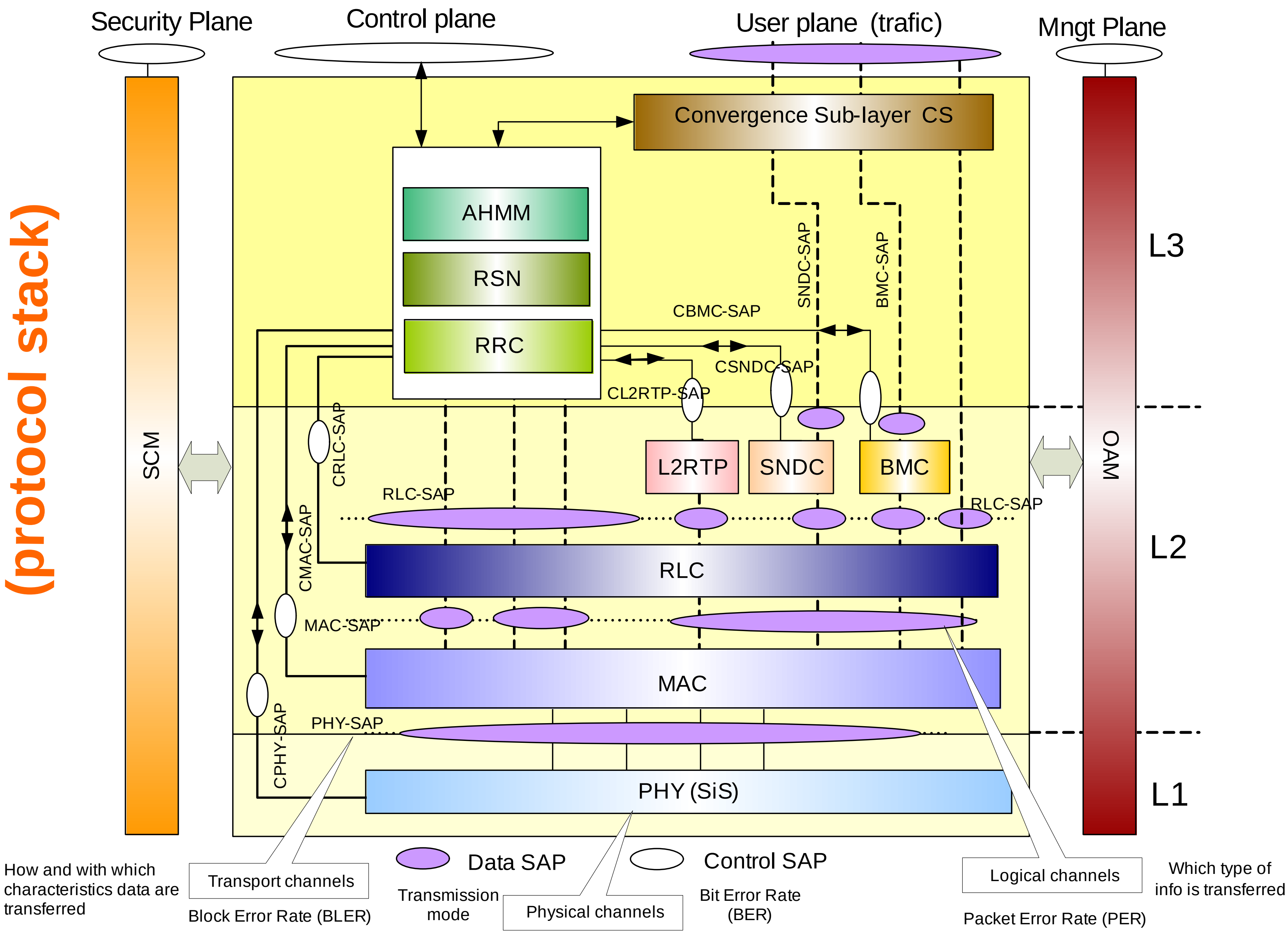
- Protocols related to the radio interface → Access stratum
  - From PHY to radio Ad Hoc routing
  - IP and legacy compatible
  - Facilities for securing WBWF protocols
- Interfaces with OAM for local and remote (OTA) supervision
- Support of (optional) GNSS interface (positioning and synchronisation features)

Architecture of the WBWF (QoS Architecture)



- Cos converted into QoS parameters at NAS service negotiation
- QoS parameters converted into routing and transmission parameters
- two levels of QoS :
  - at the radio link level between two neighbouring nodes
  - at the routing level between border nodes

Architecture of the WBWF (protocol stack)



Architecture of the WBWF (planes)

- 3 levels of information : logical, transport and physical channels
- Support of the concept of transport format
- 4 planes
  - User Plane : OTA data and signalling exchanges. Primitives at Data SAPs
  - Control Plane
    - configures the User Plane through Control SAPs
    - handles radio resource allocation and routing algorithms
  - Security Plane : security feature
    - configured according to the security level of the mission
    - Secures protocol layers through Security SAPs
  - Management Plane :
    - Local and remote management of equipment, radio interface, network
    - guarantees proper configuration and supervision of layers
    - compatible with SDR requirements
    - accesses to the protocol layers through Management SAPs

Architecture of the WBWF - layers features

- Convergence Sublayer (CS) : interface with different types of services
  - manages the sessions (IP, connection-oriented, connectionless short messages, etc.)
  - makes use of AHMM services to access a coverage area
- Ad Hoc Mobility Management (AHMM) : complement to NAS MM and routing
  - If clustering, handling of mobility between clusters or groups of clusters that belong to different areas
  - Attachment, registration, paging, etc.
  - If hierarchical clustering, handling of Location areas
  - Under control of SCM for peer entities authentication procedures
  - Makes use of RSN for access to routes

Architecture of the WBWF - layers features (2)

- Radio Sub Network (RSN): Ad Hoc Radio Networking complement NAS
  - Routing : presence detection, neighbour construction, route selection
  - Support of reactive and proactive protocols
  - If clustering, handling of clusters (creation modification, deletion)
  - RSN makes use of RRC
    - to adapt routing decisions to radio conditions
    - to effectively activate a radio link associated to a virtual route.
- Radio Resource Control (RRC)
  - Configuration for access to radio resources according (carrier frequency, transmission mode : coding scheme, ARQ protection, etc.) / QoS
    - locally to a node if flat network
    - If clustering, Cluster Head (CH) RRC instance manages resources of the nodes in its cluster, and can collaborate with its peer adjacent CHs
    - Radio link state monitoring : collect and filter lower layers measurements and reconfigure radio link accordingly

Architecture of the WBWF - layers features (3)

  - If clustering : CH collects measurement from its cluster members and reconfigure radio links accordingly
- load balancing between radio link (linked to routing)
- long term (slow) power control and fast power control parameters
- algorithms depend on the multiple access scheme
- If DS-CDMA : handling of macro-diversity (linked to cooperative routing)
- TDMA and/of OFDMA : sub network synchronisation and timing advance

AHMM, RSN, RRC : belong to Control Plane

Control Plane signalling (protocols) injected in the User Plane for OTA transfer

Architecture of the WBWF - layers features (4)

- Sub Network Data Convergence (SNDC)
  - IP traffic flow adaptation to WBWF radio interface
  - IPv4, IPv6, header compression
- Broadcast/Multicast Control (BMC)
  - Broadcasting/Multicasting data flows adaptation to coverage area
  - Service notification to the target audience
- Layer 2 Radio Tunnelling Protocol (L2RTP)
  - Regenerative relaying (possibility of different transmission format between Tx and Rx)
  - Possibility to avoid unnecessary duplications (cause multipath routing)

SNDC, BMC, L2RTP : belong to User Plane

Architecture of the WBWF - layers features (5)

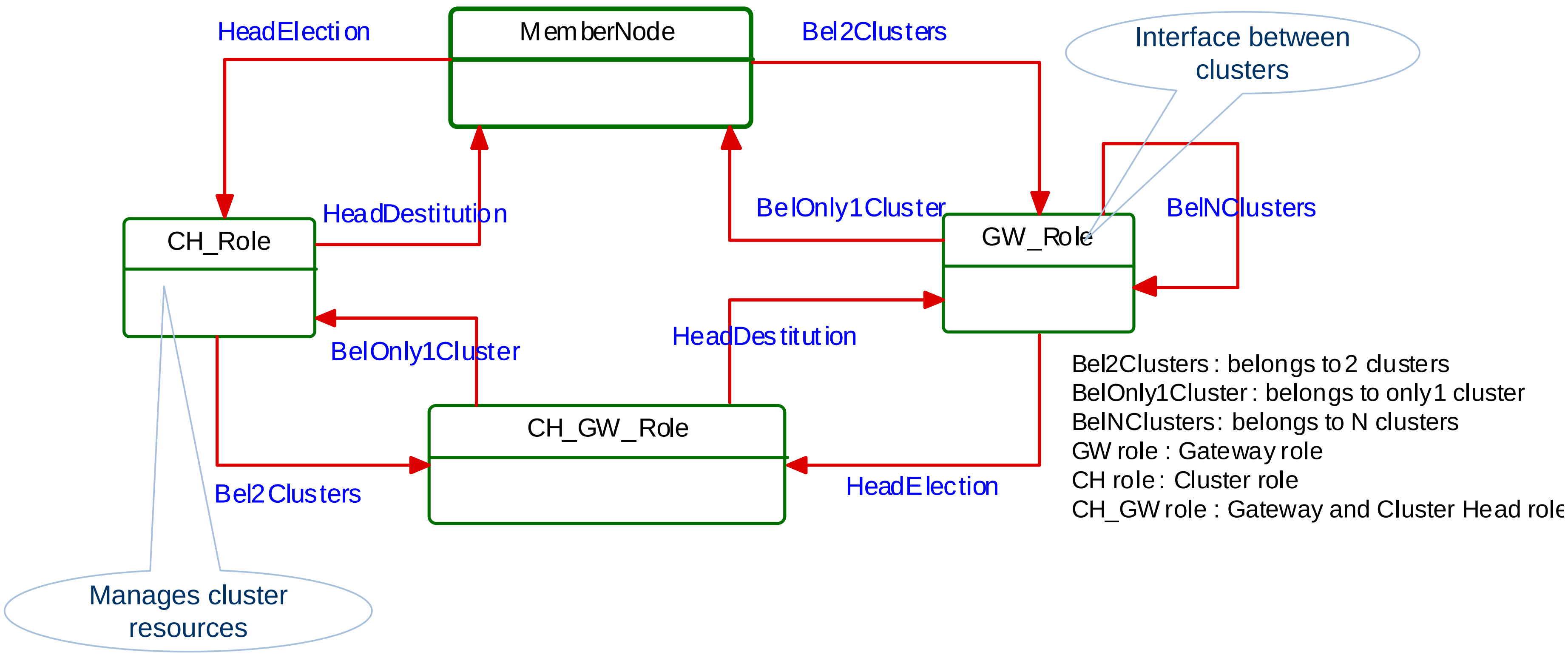
- Radio Link Control (RLC)
  - Data transfer over 1 radio hop
  - Transparent, Unack and Ack modes, Segmentation/reassembly, ARQ, etc.
  - Link re-establishment for temporary link suspension (loss or Silent Mode)
- Medium Access Control (MAC)
  - Real time scheduling of PHY, Survey of neighbouring signals
  - Random Access/CSMA
  - TDMA and/or OFDMA : Timing advance
  - Quality,Traffic volume measurements, Fast adaptation of Transport format
- Ciphering @MAC/RLC level : SCM
- Physical layer (PHY) : signal processing (mod, FEC, etc)
  - CDMA : macro-diversity
  - CDMA, OFDMA : fast power control MIMO processing
  - TRANSEC : in PHY or externalised depending on security architecture

Interworking with SCA platform

- ETARE WBWF is compatible
- ETARE WBWF is compatible with standard implementation of SDR (SCA, APIs, …).
  - OAM APIs for interface with the Management Plane
  - Security APIs for interface with the Security Plane
  - Location and synchronization APIs for interface with GNSS
  - Transceiver APIs for interface with the RF module
  - A set of application and data APIs for interface with upper layers from NAS (inter network routing and traffic sources)

Handling of flat and/or clustered networks

- Node's role state transition diagram



Thank you