



IEEE 802.21 and its usage as an access network discovery database

Workshop ITG 5.2.4, Berlin

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IEEE 802.21 "Media Independent Handover"

Overview, Architecture & MIH services

Media-Independent Information Service

Structure, Access to the IS & IS-based access network discovery

Access Network Discovery using Radio Coverage Information

Acquisition and Provision of Radio Coverage Information

Extension of the IEEE 802.21 Information Service

Summary & Conclusion

IEEE 802.21: Media Independent Handover

IEEE 802.21 defines supporting functions to improve mobility between heterogeneous networks.

- **Cross layer information exchange**
 - Provision of link layer & network-related information to higher layers
 - Standardized and media-independent interface
- **Handover optimization**
 - Enable cooperative use of information available at the mobile terminal and within the network infrastructure
 - Provide and communicate triggers to be used in handover algorithms
- **Support of (initial) access selection**
 - Provision of information about of neighbor networks

NOT in scope:

- Mobility management & protocols, Intra-technology handovers
- Security and access control

Event Service

Notification of dynamic changes in link characteristics and status, as well as management actions. Support of Remote Events. Examples:

- Link up / down / detected
- Reports on throughput, packet loss, etc.
- Handover initiated / completed

Command Service

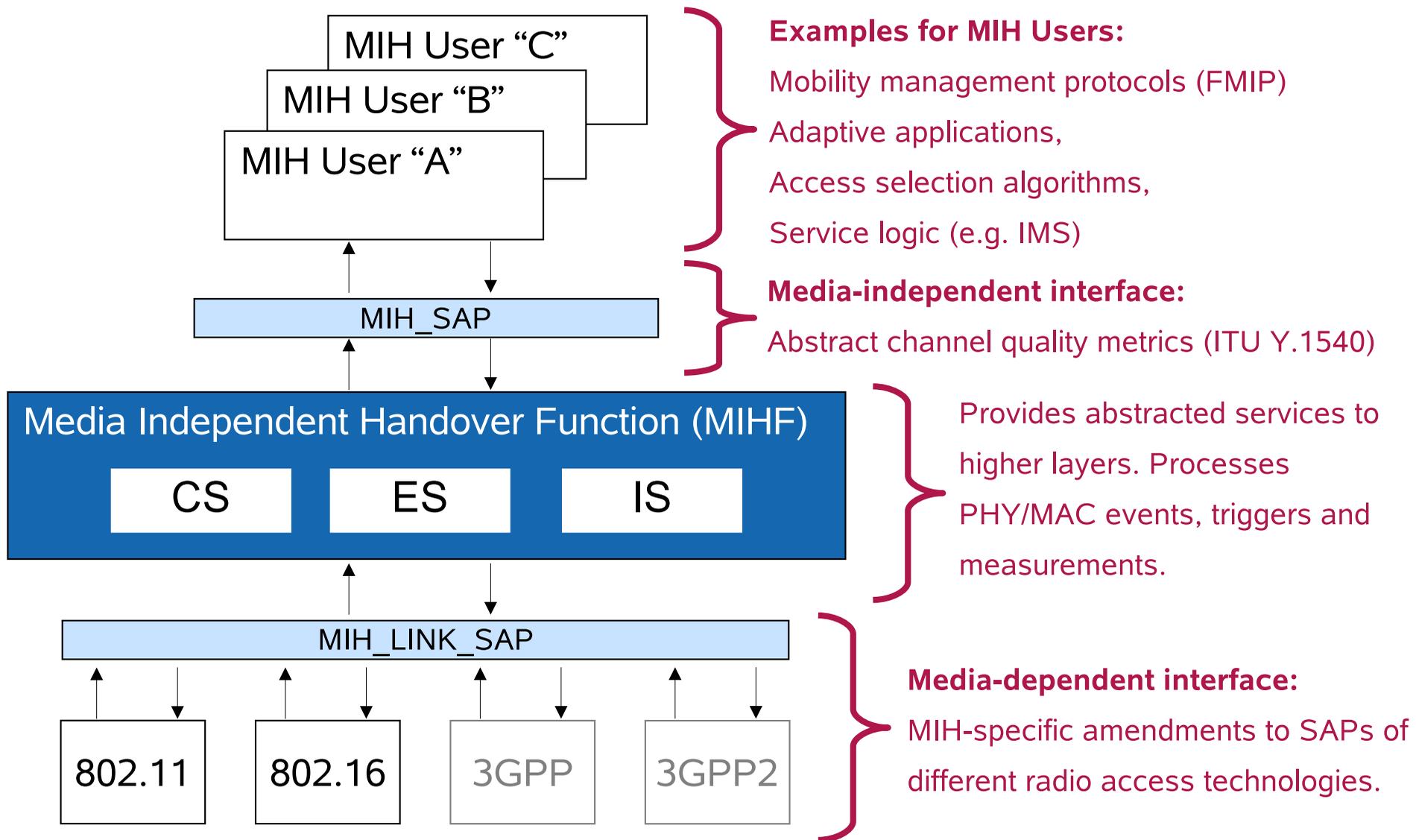
Management and control of link layer functions relevant to mobility.

- **Measurement reporting:** Link status queries, Scan for neighbor systems
- Commands for **terminal-controlled and network-controlled** handovers

Information Service

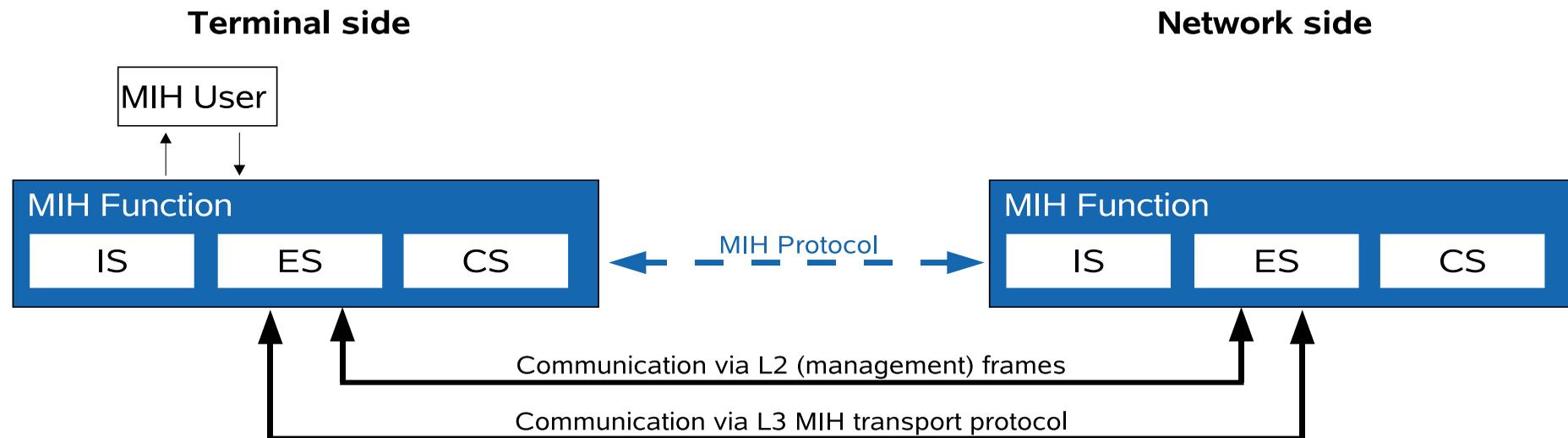
Static information about characteristics and services of the serving and neighbor networks.

Functional Architecture & Interfaces



SAP: Service Access Point

Communication Model



- **MIH protocol messages can be transported over L2 or L3**
 - depending on the primitives offered by the underlying RAT
 - depending on the location of the network-side MIH point-of-service
- **MIH transport containers for L2 defined in 802.3ah, .11u, .16u**
- **MIH transport protocol on L3 being developed by IETF MIPSHOP**

IEEE 802.21 "Media Independent Handover"

Media-Independent Information Service

Access Network Discovery using Radio Coverage Information

Summary & Conclusion

802.21 Information Service

Properties

- **Provision of (static) information about available access networks within a given geographic range**
- **Storage of access network information on Information Servers**
 - Acquisition of access network data and structure of the Information Server are out of scope of 802.21 specification

Information Element categories

- **General information**
- **Network specific information**
- **Point-of-Attachment specific information**
 - Lower layer IEs: Address, location, data rates, frequency, etc.
 - Higher layer IEs: IP configuration methods, IP subnet prefix
- **Vendor specific information elements**

Information Service Schema

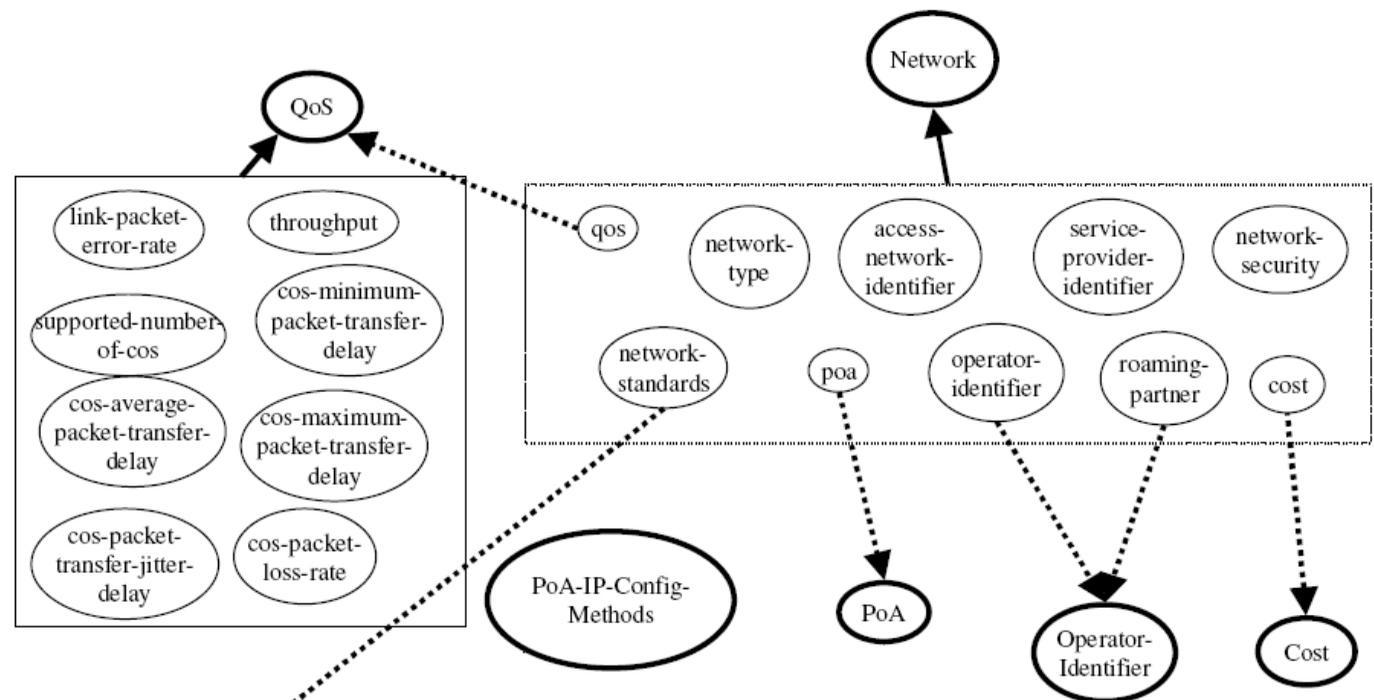
Textual schema specification using XML-based specification languages

- Resource Description Framework & Web Ontology Language
- Specification of IEs as classes and properties and relations thereof

Basic Schema: Predefined set of IEs, normative for every MIHF

Extended Schema: Optional and vendor specific elements

- ➔ Updates of extended schema by download of its textual representation



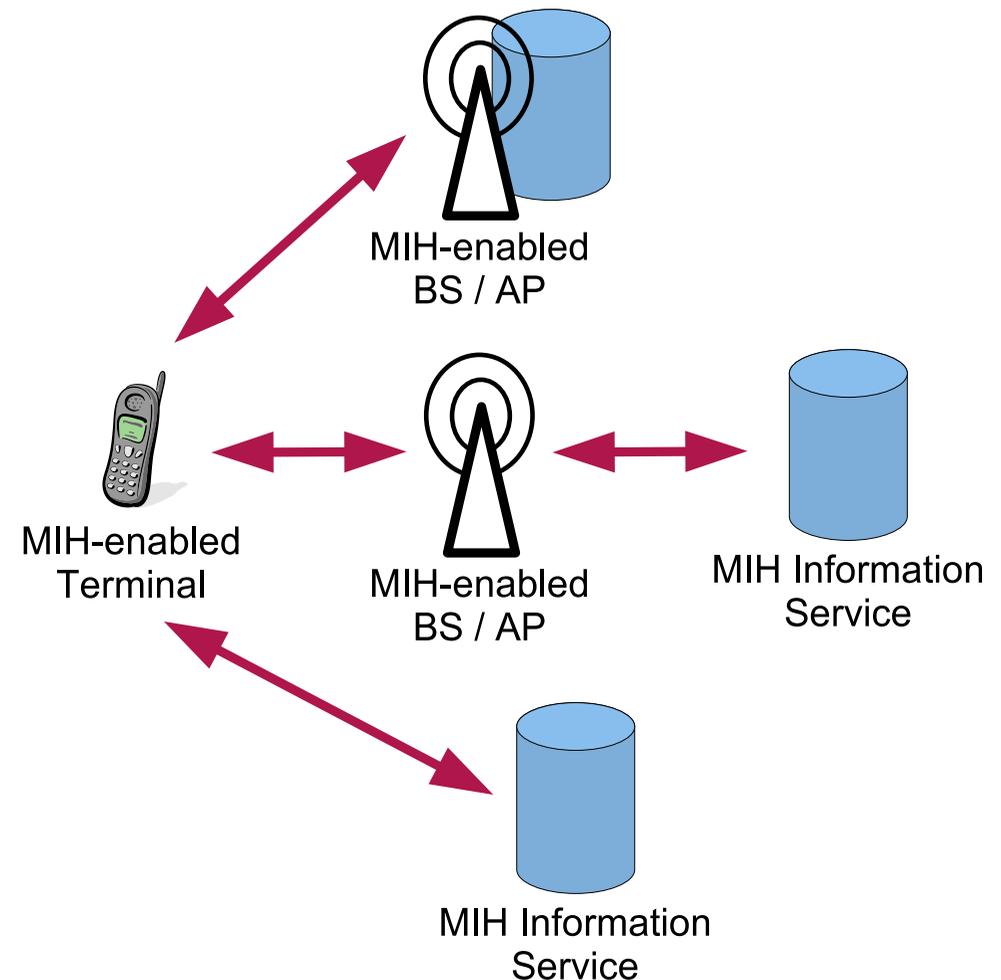
Access to the Information Service

Two approaches for information access and retrieval

- **Type Length Value**
 - TLV encoded IEs
 - Simple request-response protocol
- **RDF-based queries**
 - XML-based encoding
 - Complex query language (SPARQL)

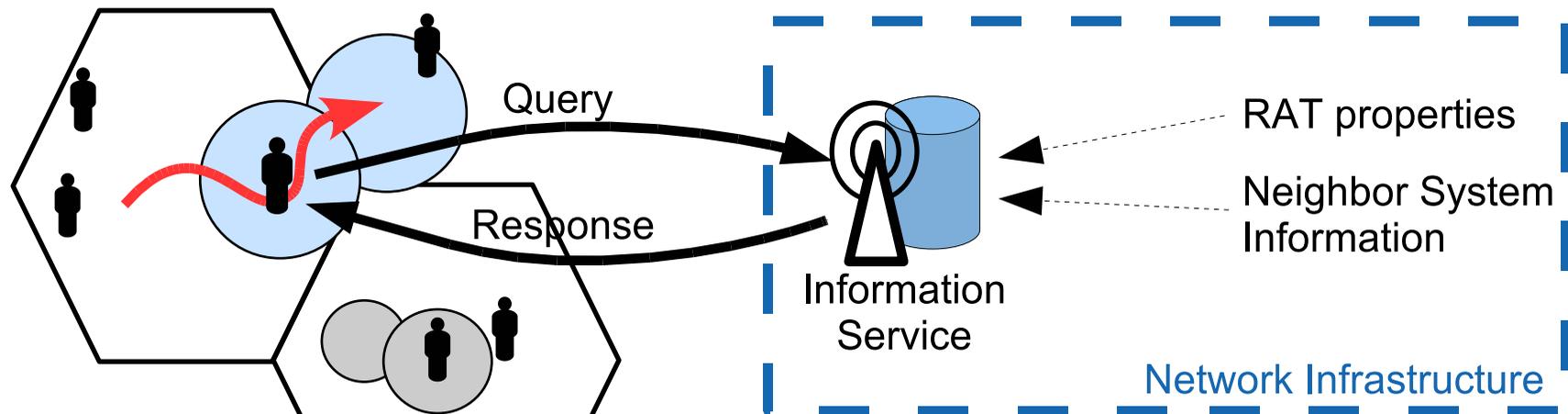
Information Server location

- **Co-located with MIH BS/AP**
- **Located in access or core network**
 - Access through other MIHF using L2/L3 protocol
 - Access via L3 MIH protocol



Access Network Discovery using the IS

Provision of neighbor network information through the IS in order to reduce energy & time spent on scanning for potential access networks.



Early access to the Information Service

1. Terminal connects to the first/default IS-enabled access network
2. IS query for (neighbor) network information **before network entry procedure is complete**
3. Scan for other access networks & connect to best-suited network

Early access to the Information Service

Amendments for early access to the IS:

- **802.11u** "Interworking with external networks"
- **802.16g** "Management plane procedure and services"

Realization:

- **Broadcast of MIH capability flag in WLAN beacon and WiMAX Downlink Channel Descriptor**
- **Restricted and rate-limited access to the IS before network entry procedure is complete**
 - **WLAN**: Access through **dedicated management frames** before the terminal is associated with the access point
 - **WiMAX**: Access through the **Primary Management Connection** before network entry procedure has been performed

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Media-Independent Information Service

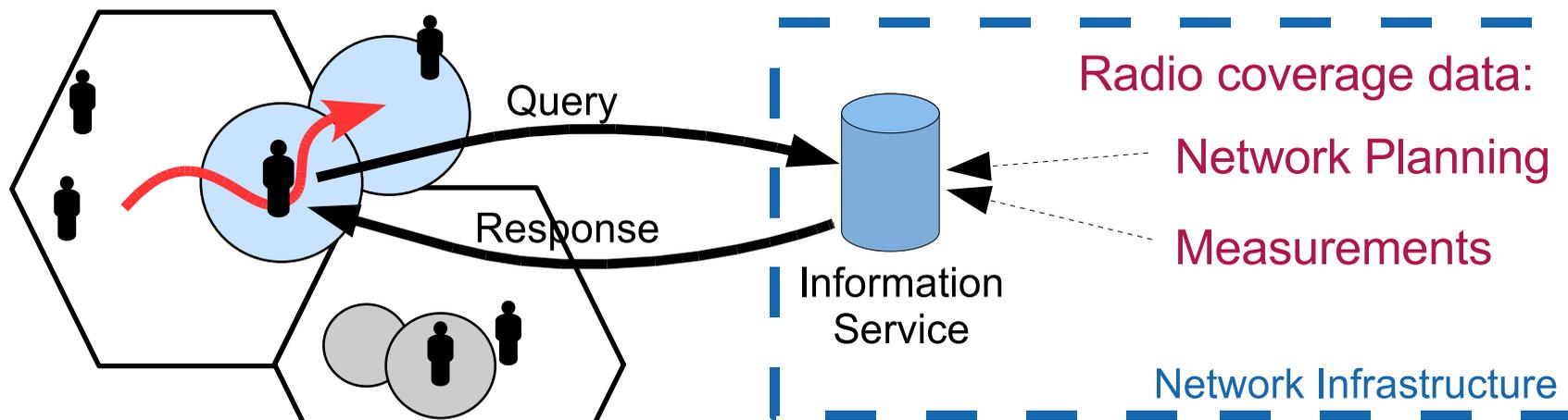
Access Network Discovery using Radio Coverage Information

Summary & Conclusion

Principal approaches

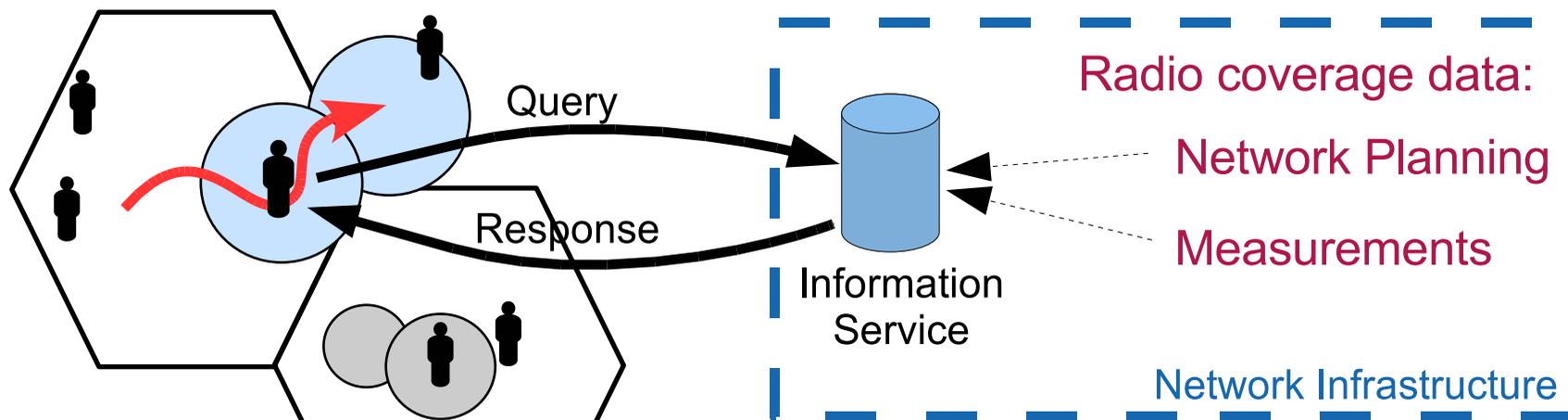
- 1. Statically preconfigured access network information**
 - ↳ Inflexible, doesn't scale
- 2. Broadcast of neighbor system information**
 - ↳ Discussions in 3GPP about how to reduce the amount of neighbor information broadcasted in UTRAN
- 3. Early access to the Information Service**
 - ↳ Requires link-layer support: not available in 3GPP
 - ↳ Security issues
- 4. Download and caching of neighbor network information, including radio coverage information ("Model-based access discovery")**

Download and caching of neighbor network information



1. Terminal downloads neighbor network information including **radio coverage area descriptions**
2. For access discovery, the terminal queries its internal database and identifies potential access networks.
3. Terminal scans for and connects to the best-suited access network.

Download and caching of neighbor network information



Properties:

- Information Service can be accessed from any IP network
- Allows for single/multiple operator scenarios
- Radio coverage data allows to plan & schedule communication

S. Lück, "Eine Architektur zur Erfassung und Bereitstellung von Netzabdeckungen von Hotspots", ITG 5.2.4, September 2005

Radio Coverage Information

Acquisition & encoding of coverage information

Radio coverage data is gained from **distributed measurements on mobile terminals**.

Requirements:

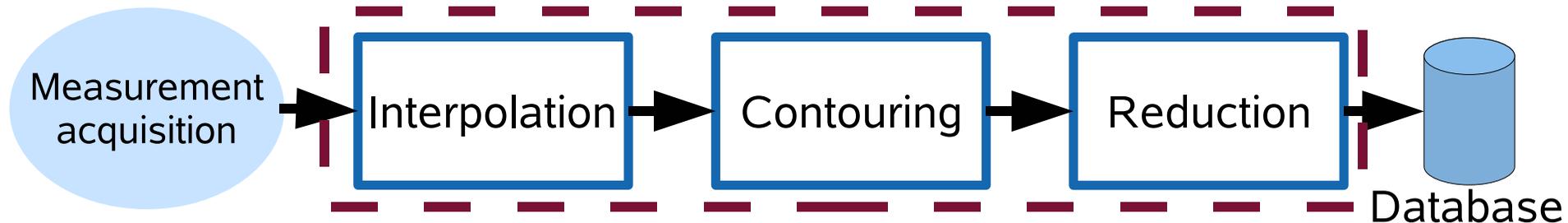
- **Accurate representation of cell / hotspot coverage area**
 - **Geometrical description to allow for uncomplicated processing**
 - **Limited data volume due to scarce radio resources**
- ↳ **Encoding of coverage area as polygons**

Provision of coverage information

Current 802.21 IS only provides means to encode geographic locations, not areas.

↳ **Extension of basic schema or encoding as extended schema.**

Acquisition of coverage information from **distributed measurements by mobile terminals** and **conversion into polygons**.

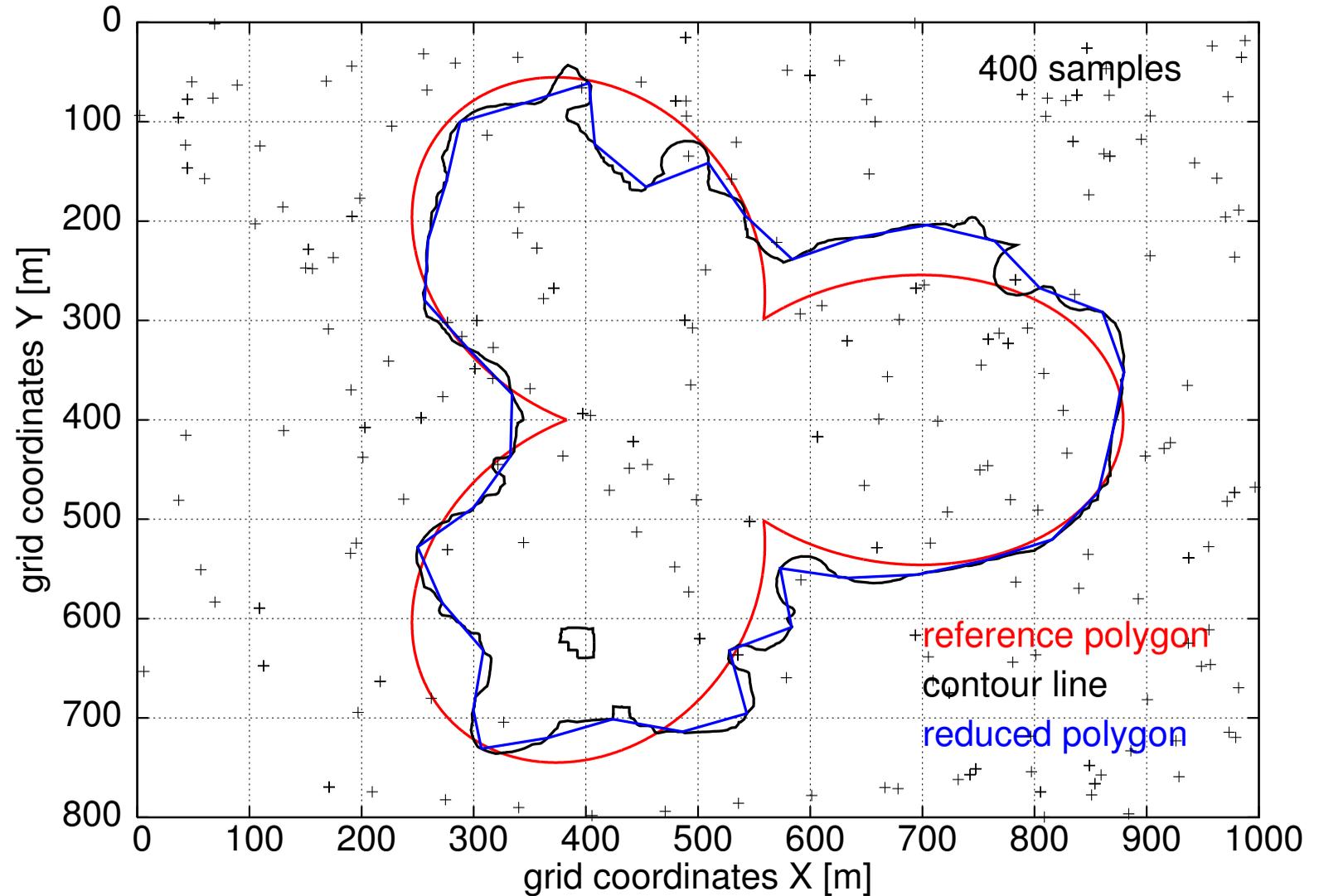


Quantitative evaluation of algorithm by means of simulation

- **Parametrization of the respective processing steps**
- **Number of measurements** required to describe a coverage area
- **Number of vertices** required to describe the corresponding polygon

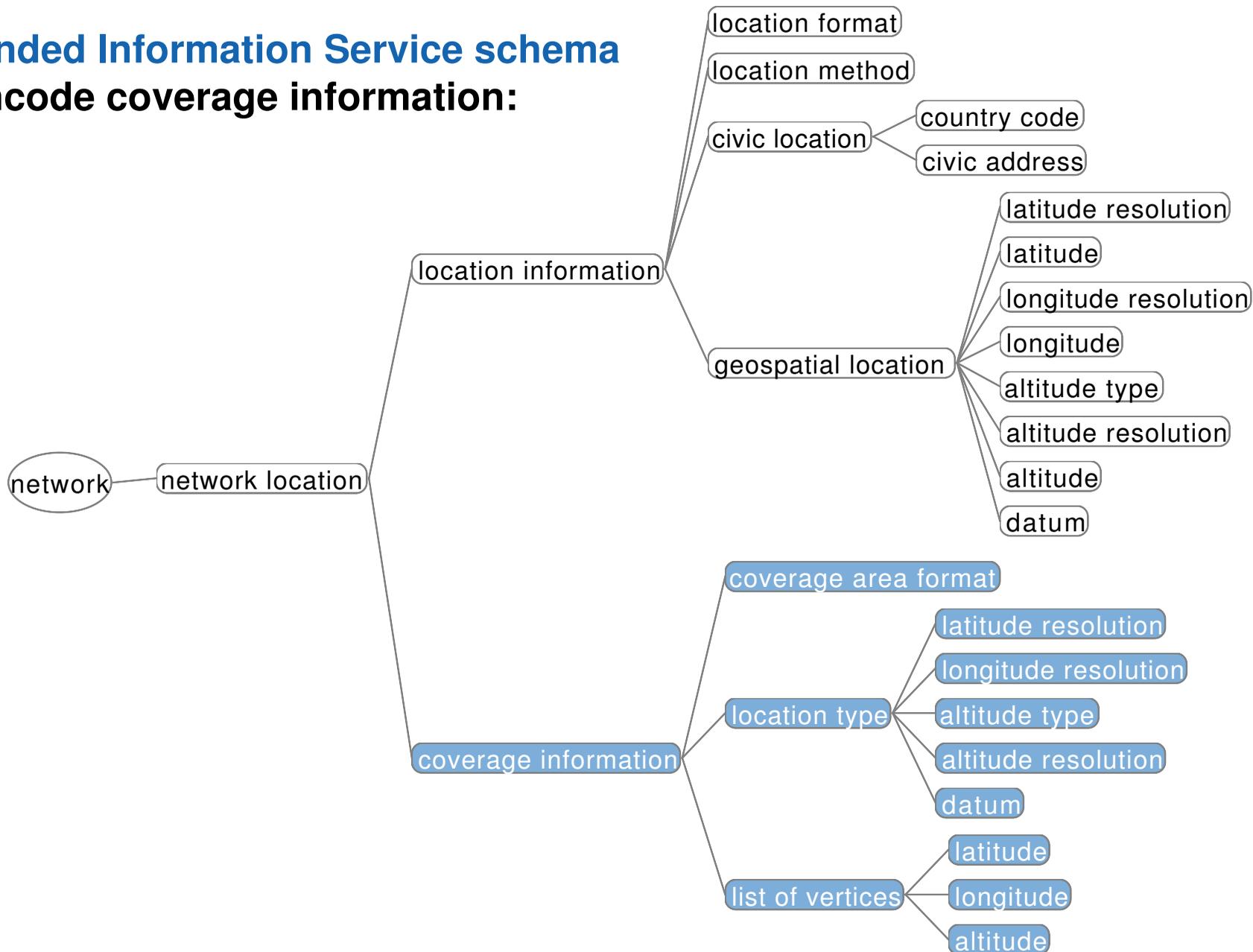
S. Lück, C.Müller, M. Scharf, R. Fetscher, "Algorithms for hotspot coverage estimation based on field strength measurements", VTC Spring 2007, Dublin (Ireland)

Sample scenario for measurement acquisition and processing



Provision of Radio Coverage Information

Extended Information Service schema to encode coverage information:



Numerical Example

Cell shape

**Diameter 500 - 600m,
omnidirectional antenna**

Number of required measurements

500 - 600 measurements

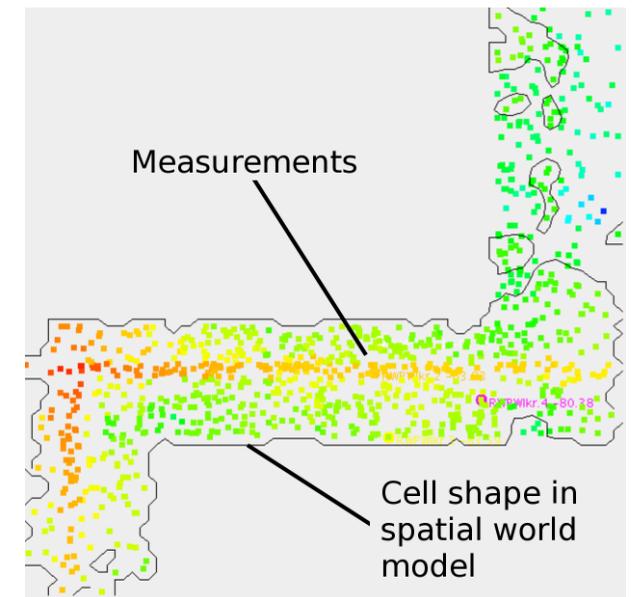
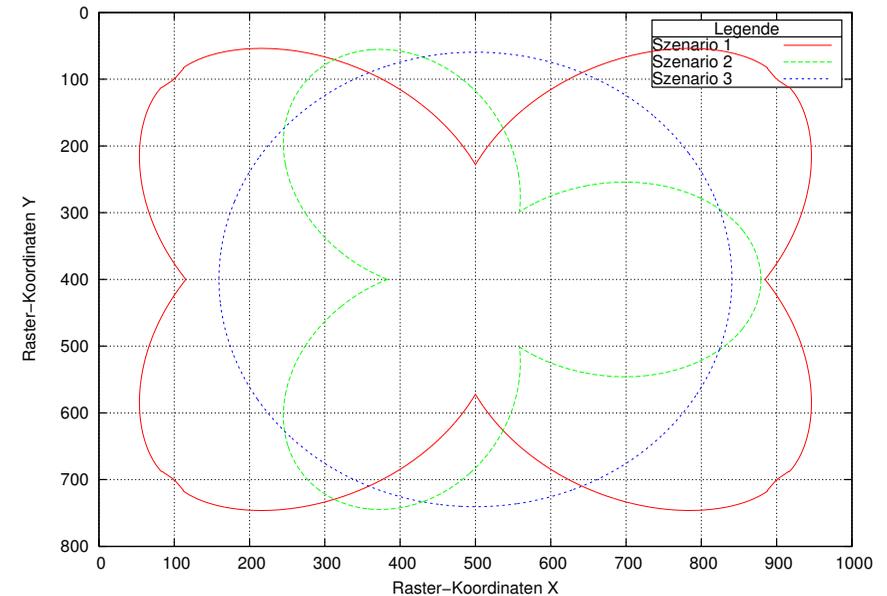
Number of vertices of polygon

Around 50

Size of data record in extended IS schema

627 Byte

(1.21 kByte for 100 vertices)



Summary & Conclusion

Overview of IEEE 802.21 Media Independent Handover

Functional architecture and interfaces.

MIH Services: Event Service, Command Service

Information Service

- **Access to the Information Service to support access discovery**
- **Early access to the IS defined for WLAN/WiMAX**

Access network discovery using radio coverage information

- **Concept: preprovisioning of neighbor network information**
- **Acquisition of radio coverage information from distributed measurements on mobile terminals**
- **Provision of radio coverage information through the IS**
 - Schema extension for encoding of radio coverage area
 - Small to moderate data volume for description of radio coverage areas



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